FORTY-FOURTH ANNUAL REPORT

For 1924-25

OHIO
Agricultural Experiment Station

WOOSTER, OHIO, U. S. A., MARCH, 1926

BULLETIN 392

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Forty-Fourth Annual Report

OF THE

Ohio Agricultural Experiment Station

For the Year ended June 30, 1925

Published by the order of the State Legislature

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HON. A. V. DONAHEY,
Governor of Ohio:

SIR: I have the honor to present herewith the forty-fourth annual report of the Ohio Agricultural Experiment Station for the year ended June 30, 1925.

C. G. WILLIAMS,
Director

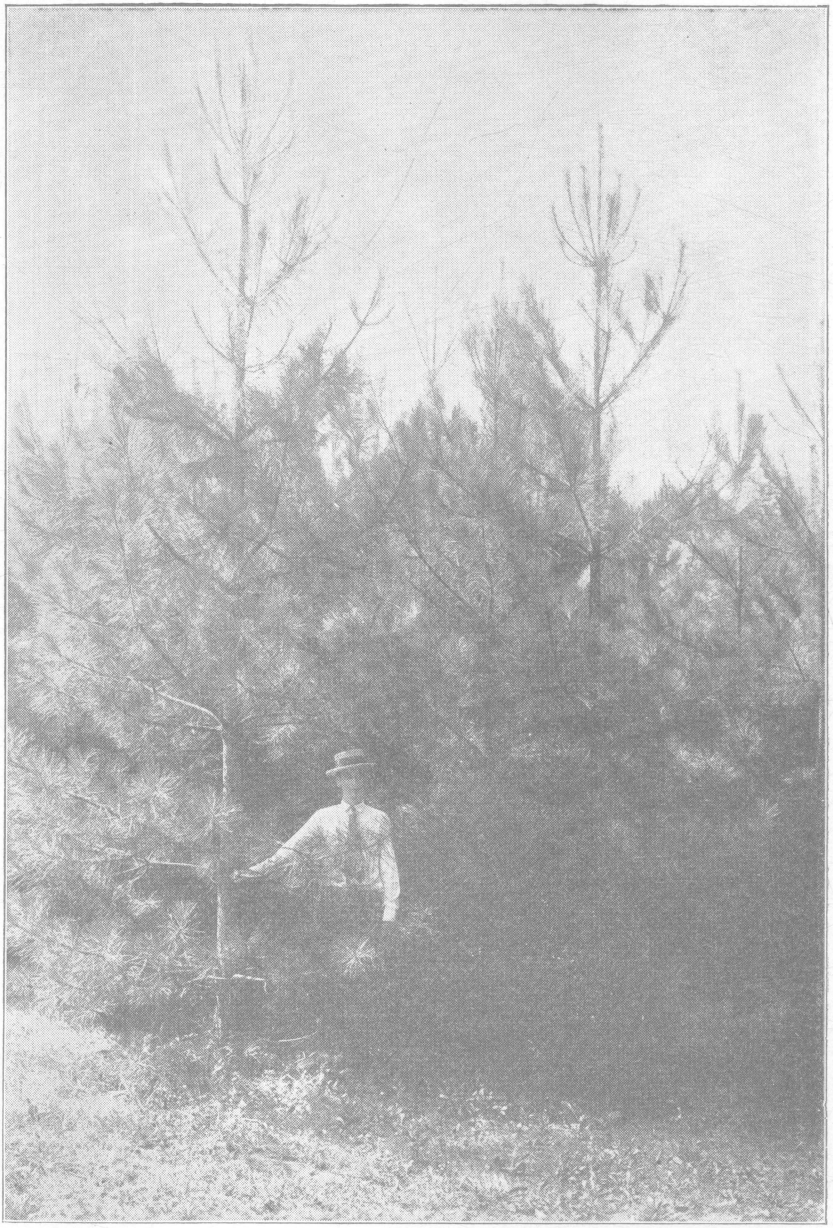

Fig. 1.—Corsican pine, a promising tree for reforestation

OHIO AGRICULTURAL EXPERIMENT STATION

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C. R. CUTRIGHT, Ph. D. ..... Assistant
L. L. HUBER, Ph. D. ..... Assistant
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J. B. POLIVKA, M. S. ..... Field Assistant

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SCOTT HARRY ..... In charge Arboretum
JOHN WITHERS ..... Ranger Waterloo State Forest
CARLOS GRAHAM ..... Ranger Shawnee State Forest
WILLIAM DEBOLT ..... Ranger Scioto State Forest

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DONALD COMIN, B. S. ..... Assistant
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ROY MAGRUDER, B. S. ..... Assistant
J. S SHOEMAKER, Ph. D. ..... Assistant
ORA FLACK ..... Foreman of Orchards
C. G. LAPER ..... Foreman of Greenhouses
G. R. MANN ..... Florist
O. N. RILEY ..... Foreman Washington Co. Truck Farm

MISCELLANEOUS

W. H. ALEXANDER[2] ..... Climatologist (Columbus)
WILLIAM H. KRAMER ..... Bursar
W. K. GREENBANK ..... Editor
SARAH PAINTER, A. B. ..... Librarian
W. J. HOLMES ..... Printer
DORA ELLIS ..... Mailing Clerk
M. S. DAWSON ..... Photographer
GLENN HALL ..... Engineer

DISTRICT AND COUNTY EXPERIMENT FARMS

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J. T. WILSON, *Supt.*

Southeastern Test Farm, Carpenter
S. C. HARTMAN, M. S., *Supt.*, Marietta

Southwestern Test Farm, Germantown
HENRY M. WACHTER, *Supt.*

Miami Co. Experiment Farm, Troy

Madison Co. Experiment Farm, London
H. W. ROGERS, *Supt.*, London, O.

Paulding Co. Experiment Farm, Paulding
H. R. HOYT, *Supt.*, Wooster

Clermont Co. Experiment Farm, Owensville

Hamilton Co. Experiment Farm, Mt. Healthy
W. E. WEAVER, *Supt.*, Mt. Healthy

Washington Co. Experiment Farm, Fleming
S. C. HARTMAN, M. S., *Supt.*, Marietta

Washington Co. Truck Experiment Farm,
O. N. RILEY, *Foreman* Mariette

Mahoning Co. Experiment Farm, Canfield
L. W. SHERMAN, B. S., *Supt.*, Canfield

Trumbull Co. Experiment Farm, Cortland
C. H. CRAWFORD, B. S., *Supt.*, Cortland

Belmont Co. Experiment Farm, St. Clairsville
G. M. DEGROFT, *Supt.*, St. Clairsville

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[1]In cooperation with College of Agriculture, Ohio State University.
[2]In cooperation with the U. S. Department of Agriculture.

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CONTENTS

First Annual Vocational Agriculture Field Day at the Ohio Agricultural Experiment Station, May 27, 1925

A PROGRESS REPORT OF THE DIRECTOR ON THE STATION'S WORK FOR THE YEAR ENDED JUNE 30, 1925

SPECIAL FIELD DAYS

The following special days for study of the Station's work and conference on related problems were held during the year. Unless otherwise indicated the meetings were at Wooster.

On August 14, 1924 the potato growers of the State inspected the Station's potato experiments and heard addresses pertaining to potato culture.

At the annual orchard meeting, August 15, the greater part of the day was spent in the field studying the experiments in horticulture. Addresses were given by out-state speakers and others.

The annual field meeting of the forestry association was held October 2 and 3 at the new forest parks in Hocking County.

The first vocational day was held at the Station on May 27, when close to 1,000 students and teachers of vocational agriculture from nearly every county of the State were present. A full day was spent in study of the Station's work.

The annual livestock day was held May 29. At the conclusion of the program at Wooster seven carloads of livestock under experiment, comprising 84 cattle and 173 hogs, were shipped first to Fostoria for a livestock day June 1, then to Washington Court House for June 3, and to Dayton, June 5, where most of the stock was sold.

Poultry day, June 25, was devoted to a study of the experimental work in progress, including 4,000 chicks raised on the all-mash method of feeding and 1,200 layers. In the afternoon the visitors were addressed by leading authorities and specialists in poultry hubandry.

Wheatfield day was held June 26.

Truck growers' day was held June 29, on the Station's special truck farm near Marietta.

Almost every day in the month of June was assigned to a different county, Smith-Hughes, farm bureau, or grange group for the study of Station work. On many days three and four delegations were present.

Field days for the inspection of experimental work on the county and district experiment farms were held as follows:

Madison County, June 26, 1924
Clermont County, July 22, 1924
Hamilton County, July 23, 1924
Trumbull County, August 9, 1924
Southwest Test Farm, August 20, 1924
Miami County, September 4, 1924
Paulding County, September 10, 1924
Mahoning County, September 17, 1924
Southeast Test Farm, September 30, 1924

Many nearby counties held field days at the various county experiment farms.

CHANGES IN STATION STAFF

RESIGNATIONS

W. A. Simpkins, assistant in Agronomy; A. W. Nettleton, superintendent Mahoning and Trumbull County Experiment Farms; P. S. White, assistant in Animal Industry; A. Bonazzi, assistant in Soils.

APPOINTMENTS

R. W. Gerdel, assistant in Agronomy; Chas. Crawford, assistant in District and County Experiment Farms; A. G. Newhall, assistant in Botany and Plant Pathology; H. L. Sassaman, assistant in Animal Industry; R. M. Salter, chief in Agronomy.

PUBLICATIONS

The Station's publications are of three classes: A bimonthly bulletin of short, timely articles, which is sent to the entire State mailing list of some seventy thousand names; monograph bulletins, which are mailed upon request only; and a weekly press bulletin.

During the year the following bulletins were issued:

BIMONTHLY BULLETINS

Subject treated	Number pages	Edition printed	Total no. of pages
July-August, 1924			
Poultry investigations			
Seed treatment to prevent smuts of wheat			
The 5-year rotation fertilizer experiment			
Hessian fly, wheat insect survey, 1924			
Vinegar			
Peach diseases	32	74,000	2,368,000
September-October			
Rickets and paralysis in swine affected by nutrition			
Comparison of soybean oilmeals for supplementing corn for hogs			

Subject treated	Number pages	Edition printed	Total no. of pages
Essentials in ration of fall pigs Corn substitutes for hogs Photographing pigs with the aid of the "focus frame" Bread and the diet A simple mineral mixture for chickens Raising Easter broilers Feeding lambs for market Treatment for stomach worms of sheep Cornfield alone inadequate for lambs Fattening calves, yearlings, and two-year-olds	48	76,300	3,662,400
November-December Home-grown vs. foreign red clover seed European corn borer Mexican bean beetle Cooperative livestock shipping in Ohio Self-feeders for hogs	40	77,850	3,114,000
January-February, 1925 How deep should we plow? Cost of growing apple trees under tillage and grass-mulch Fertilizing young apple orchards Some mistakes in orcharding Potato spraying and dusting in 1924 Ohio certified seed potatoes Feeding the chicks The European starling in Ohio Sprays control San Jose scale Cattle feeding tests	32	75,700	2,422,400
March-April Minerals in the dairy ration When should sweet clover be plowed down? The Japanese beetle Spraying for apple scab and apple blotch Infested corn stalks should be burned Protected woodlot becomes farm asset Feeding for eggs	32	75,800	2,425,600
May-June Fertilizing corn in 1924 Forest fires denude 15,000 acres The tractor on Ohio farms The oriental peach moth Dairy cows need grain with pasture Selecting foundation dairy cows Intestinal coccidiosis in fowls Canada thistle eradication Insanity among farmers' wives Some effects of fire in pine hardwood forests in southeastern Ohio	32	75,800	2,425,600

MONOGRAPH BULLETINS

No.		Number pages	Edition printed	Total no. of pages
374	Potato diseases	32	7,000	224,000
375	Cooperative livestock marketing in Ohio	56	7,000	392,000
376	Effect of high and low protein content on the digestibility and metabolism of dairy rations	36	4,500	162,000
377	Manure and fertilizers for truck crops	40	6,000	240,000
378	Anthelmintic intestinal worms—experiments with hogs	32	5,000	160,000
379	Soil potassium as affected by fertilizer treatment and cropping	32	5,000	160,000
380	Availability of phosphorus in calcareous and non-calcareous soils	32	4,000	128,000
381	The maintenance of soil fertility	116	8,000	928,000
382	Annual report	72	76,000	5,472,000
383	The tractor on Ohio farms	32	6,000	192,000
384	The soybean in Ohio	40	6,000	240,000
	Soil survey of Miami County, Ohio	90	3,500	315,000

REPRINTS

24	Monograph bulletins	1,432,000
12	Bimonthly bulletins	696,000

PRESS BULLETINS

52	Press bulletins	104,000
	Total pages printed during the year	27,263,000

TECHNICAL PAPERS

Salter, Robt. M., Climatic agencies in their relation to soil colloids. Jour. Amer. Soc. Agron. 17:294-307, 1925.

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Bethke, R. M. and D. C. Kennard, Rearing chicks to maturity indoors. Poultry Science, Vol. IV, No. 2, Dec.-Jan., 1924-1925.

Bethke, R. M., D. C. Kennard, and M. C. Kik, Nutritional studies of the growing chick. The relation of sunlight and green clover to leg weakness in chicks. Jour. Bio. Chem., Vol. LXIII, No. 2, March, 1925.

Robison, W. L., The influence of the method of oil extraction on the feeding value of soybean oilmeals. Proc. Am. Soc. An. Prod., 1924.

Huber, L. L., Some spray tests with oil emulsions. Jour. Econ. Ent., Vol. 18, No. 3, June, 1925.

Huber, L. L., and C. R. Neiswander, On certain behavior of the European corn borer, *Pyransta nubilalis*. Jour. Econ. Ent., Vol. 18, No. 1, Feb., 1925.

Cutright, C. R., Some studies in aphis control. Proc. Ohio State. Hort. Society, 1925, pp. 46-55.

Miller, A. E., The native host of the chigger. Science, LXI, No. 1578, pp. 328-330, 1925.

Houser, J. S., Present aspects of San Jose scale control. Proc. Ohio State Hort. Soc., 1925, pp. 37-45.

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Winter, A. R., The utilization of minerals by ewes during the period of gestation. Am. Jour. Physiol. LXXIII, 379, 1925.

ACID PHOSPHATE VS. RAW ROCK PHOSPHATE

In 1897 this Station began a test in which equal amounts by weight of raw rock phosphate and acidulated phosphate were used as a supplement to manure in a 3-year rotation of corn, wheat, and clover. The manure has been used at the rate of 8 tons and the phosphate at the rate of 320 pounds per acre, both being applied to the corn crop, the other crops of the rotation being without treatment.

The average yields, the increase as compared with the check plots, and the value of the increase from both the manure used alone and the manure and phosphates are given in Table 1. The difference between the two shows the gain for phosphate. In order to show the tendencies of these treatments the data are given in two periods, the first covering 5 rotations or 15 years, the second 13 years.

Making the necessary subtractions and averaging the results with the yard and stall manure, it will be found that acid phosphate increased the yields during the first period to the amount of $24.99, and during the second period, $20.14; while raw rock phosphate made increases of $16.62 and $3.83. This decline in the *increases* is due in part to the larger yields of the check plots in the later years, due to a greater response to the liming of all the plots begun the middle of the first period. The actual yields of corn and wheat were higher in the second period than in the first; but the *relative* effect of the phosphate was not as great, and the raw rock phosphate fared decidedly worse than the acid phosphate. The increasing alkalinity of the soil resulting from regular liming is probably responsible for much of the reduction in efficiency of the raw phosphate.

In 1905 a second comparison of acid phosphate and raw rock phosphate was started. In this test the phosphate is used alone, and in conjunction with muriate of potash.

As in the manure test the treatment is all applied to the corn crop. Oats take the place of wheat in the rotation. The phosphate is applied at the rate of 320 pounds per acre and the muriate of potash at the rate of 40 pounds.

It will be noted that the actual yields were higher in every instance where acid phosphate was used, and that the comparison with the check plots as shown by the increase was also in favor of acid phosphate, except in one instance.

A third comparison of these phosphates was started in 1915 in which an attempt was made to use approximately equal money values per acre. The amount of the application is based on prices

prevailing when the test started and is 480 pounds of acid phosphate and 768 pounds of raw rock phosphate. As in the first test, 8 tons of manure per acre is used with the phosphate and both are applied to the corn crop; oats, wheat, and clover following without fertilization. All the plots have been limed regularly from the start.

In this test, as in the earlier tests, acid phosphate has proved superior to raw rock phosphate.

TABLE 1.—Acid Phosphate Vs. Raw Rock Phosphate The Manure, Lime and Floats, and Fry Farm Fertility Experiments

Plot No.	Treatment	Yield per acre				Increase per acre				Value of increase per acre per rotation Dol.
		Corn Bu.	Oats Bu.	Wheat Bu.	Hay Lb.	Corn Bu.	Oats Bu.	Wheat Bu.	Hay Lb.	
	A	Manure experiment—first period, 15 years								
5	Y. M.* and ac. ph.	62.31	.....	24.84	4,376	30.97	.....	14.75	2,032	59.04
2	Y. M. and floats	61.98	.....	24.01	4,540	25.31	....	12.53	1,681	49.12
15	Y. M.	53.17	.....	19.26	3,446	19.36	....	9.02	920	33.98
6	S. M. and ac. ph.	66.05	.....	25.47	5,077	34.95	.....	15.75	2,724	68.52
3	S. M. and floats	65.41	.....	25.39	5,021	31.29	.....	14.42	2,423	61.70
16	S. M.	59.49	.....	20.69	4,149	23.88	.....	10.32	1,520	43.60
		Manure experiment—second period, 13 years								
5	Y. M. and ac. ph.	70.56	.....	33.55	4,594	32.11	.....	15.32	1,483	56.58
2	Y. M and floats	69.70	.....	29.07	4,251	26.59	.....	8.91	882	38.60
15	Y. M.	61.28	.....	27.92	3,925	23.84	.....	9.18	796	36.43
6	S. M. and ac. ph.	73.53	.....	33.61	4,741	36.40	.....	15.17	1,652	60.62
3	S. M. and floats	72.01	.....	30.05	4,339	30.57	.....	10.97	1,085	45.99
16	S. M.	67.00	.....	28.21	4,179	26.19	.....	9.64	1,026	40.49
	B	Lime and floats experiment—21 years								
20	Ac. ph.	47.77	44.32	.....	2,738	7.82	4.09	.....	188	8.52
23	Floats	42.96	41.69	.....	2,631	5.19	3.45	.....	213	6.61
21	Ac. ph. and m. p.	53.52	45.22	.....	2,836	14.11	5.52	.....	306	14.38
24	Floats and m. p.	47.03	41.69	.....	2,562	10.36	4.36	.....	236	10.77
	C	Fertilizer experiment—Fry Farm—11 years								
33	Manure and ac. ph.	72.55	59.44	32.49	4,074	19.95	8.05	9.44	815	37.46
38	Manure and floats	69.88	57.68	28.18	3,660	13.59	4.37	5.14	308	21.28

*Y. M., yard manure; S. M., stall manure; ac. ph., acid phosphate; m. p., muriate potash; floats, raw rock phosphate.

A COMPARISON OF FERTILIZER ANALYSES

A field test has been in progress since 1915 in which 16 percent acid phosphate and several mixed fertilizers are compared. All are used at the uniform rate of 1000 pounds per acre in a 4-year rotation of corn, oats, wheat, and clover. All plots receive 2 tons of ground limestone per acre applied to the clover sod in the winter and plowed down for corn in the spring. The soil is a Canfield silt loam, possessing somewhat poorer natural drainage, but otherwise quite similar to the Wooster silt loam upon which the older fertility tests

of the Station have been conducted. This soil is tile drained and is in a fairly good state of production as indicated by 11-year average yields on the unfertilized check plots as follows: corn, 54.26 bu; oats, 52.33 bu; wheat, 24.38 bu; and clover, 3,623 pounds.

The 11-year average increase due to the fertilizers, the value of the increase for the rotation, the cost of the fertilizers, and the net increase obtained by deducting the cost of the fertilizer from the value of the increase are given in Table 2. For all plots shown except 2 and 3 the fertilizer is divided equally between corn and wheat, each crop receiving 500 pounds per acre. On Plots 2 and 3, 250 pounds of fertilizer is applied to each crop in the rotation. This difference in the distribution of the fertilizer prevents a strict comparison between Plots 2 and 3 and the remaining plots. The fertilizer used on Plot 8 has given increases for corn larger by 23 percent, for oats smaller by 21 percent, for wheat larger by 35 percent, and for clover smaller by 24 percent, and a 15 percent larger total value of increase than on Plot 5, where the same fertilizer is divided equally among the four crops. It may be assumed that the increases on Plots 2 and 3 would have been similarly affected had the fertilizer been applied one-half on corn and one-half on wheat. The values for the total increases on these plots have been corrected accordingly to permit a better comparison with the other analyses.

TABLE 2.—Increase and Net Return from the Use of Different Proportions of Ammonia, Phosphoric Acid, and Potash

Plot	Analysis 1000 lb. per acre per rotation	11-year average increase per acre				Values per acre per rotation		
		Corn	Oats	Wheat	Clover	Total increase	Cost fertilizer*	Balance
		Bu.	*Bu.*	*Bu.*	*Lb.*	*Dol.*	*Dol.*	*Dol.*
2	0—16—0	9.26	3.51	8.15	641	28.66†	10.80	17.86
3	0—12—4	12.74	7.43	8.87	983	37.45†	13.45	24.00
8	2— 8—2	11.94	4.55	13.03	691	34.90	14.40	20.50
17	4— 8—4	15.61	5.81	14.04	925	41.25	18.20	23.05
18	4— 8—8	17.68	5.81	14.65	945	43.76	19.60	24.16
15	4—12—2	15.55	5.51	14.90	1,087	43.59	19.00	24.59
14	2—12—2	14.67	6.49	14.73	1,057	42.89	15.90	26.99

*1925 fall prices used for both acid phosphate and mixed fertilizers.
†Values corrected for difference in distribution of fertilizers between crops as indicated in text.

On this soil, which receives no manure and from which all crops are removed, acid phosphate, altho an excellent investment, has produced a lower net increase than any of the mixed fertilizers. Replacing 4 percent of the phosphoric acid of the acid phosphate by an equal amount of potash, making an 0-12-4, has raised the total increase $8.79 and the net increase $6.14. The effect of the potash

is less apparent on the wheat than upon the other crops of the rotation. When an additional 4 percent of phosphoric acid is replaced by 4 percent of ammonia, making a 4-8-4, the net increase falls below that produced by the 0-12-4. Cutting both ammonia and potash to 2 percent (Plot 8) still further decreases the net increase. However, where these amounts of ammonia and potash are used and the phosphoric acid raised to 12 percent, making a 2-12-2, the net increase is the highest obtained from any of the treatments. The phosphoric acid carried in 1000 pounds of 2-12-2 is equivalent to 750 pounds of 16 percent acid phosphate, that in 1000 pounds of 2-8-2 to 500 pounds of acid phosphate. Adding 250 pounds of acid phosphate to the 2-8-2 increased the cost by only $1.50 but increased the gross return by $7.99.

Under the conditions of the test the purchase of ammonia in addition to phosphoric acid and potash appears unwise until the amount of phosphoric acid used is increased beyond the equivalent of 500 pounds of 16 percent acid phosphate in a 4-year rotation. Raising the ammonia in the 2-12-2 to 4 percent (Plot 15) decreased the net return, while adding 4 percent more potash to the 4-8-4 gave slightly more net increase. The additional potash benefitted the corn crop relatively more than the wheat crop.

Using the data from this experiment as a guide for choosing fertilizer analyses for corn and wheat where grown under conditions similar to those of this test, and confining ones choice to the "Ohio Standard Dozen Fertilizers", it would appear that either the 0-14-4 or the 2-12-6 would be the logical choice for corn, and either the 2-12-2 or the 2-16-2 for wheat.

WHAT CROPS SHOULD BE FERTILIZED?

The work reported under this head in the Forty-first Annual Report has been continued, and it is thought best to make a further progress report of it. A uniform amount of fertilizer consisting of 500 pounds of 16 percent acid phosphate, 108 pounds of nitrate of soda, and 40 pounds of muriate of potash per acre is used each rotation period of 4 years. On one set of 4 plots it is divided equally among the crops of the rotation—corn, oats, wheat, and clover. On another it is divided equally among the three cereal crops, the clover not being fertilized. On another it is divided equally between corn and wheat; while on three other sets of plots it is all applied to the corn crop, all on wheat, and all on clover, respectively. All of the plots in this test, including the check plots, receive 2 tons of ground limestone per acre on each corn crop.

Table 3 gives the increase in yield for each crop under the different methods of fertilization as compared with the unfertilized check plots between which it lies, and the total value of the increases per acre per rotation. The total corrected yield may be found by adding the increase to the average yield of the unfertilized plots given in the table.

TABLE 3.—Increase from Fertilizers Applied to Different Crops in Rotation

Plot	Crops receiving fertilizer	11-year average increase per acre				Value of increase per rotation
		Corn	Oats	Wheat	Clover	
		Bu.	*Bu.*	*Bu.*	*Lb.*	*Dol.*
5	All four crops equally.....	9.70	5.74	9.65	907	30.36
6	Corn, oats, and wheat.....	11.77	6.82	12.30	526	33.36
8	Corn and wheat.....	11.94	4.55	13.03	691	34.90
9	Corn.....	14.29	6.30	7.68	367	26.79
11	Wheat.....	8.34	2.50	14.90	1,065	37.17
12	Clover.....	12.03	3.06	6.20	1,461	29.90
	Av. yield unfertilized plots.....	54.26	52.33	24.38	3,623	.....

In determining the value of the increase corn is valued at 70c per bushel, oats 40c, wheat $1.50, and clover hay $15 per ton. The increases of straw and stover are not included in the final column.

At these valuations it has proved most profitable to date to apply all of the fertilizers of the rotation (648 lb. per acre) to wheat; with an equal division between corn and wheat second in profit.

WHAT CROPS SHOULD BE MANURED?

A somewhat similar study has been made in the use of phosphated manure. In this test 8 tons of manure and 480 pounds of acid phosphate have been used each 4-year rotation, applied half and half on corn and wheat, all on corn, all on wheat, and finally all on the new seeding of clover soon after wheat harvest. The phosphated manure has been plowed under for corn, and applied after plowing, tho before drilling, for wheat. The 11-year average increases and their value per acre per rotation are shown in Table 4.

TABLE 4.—Increase from Manure Applied on Different Crops in Rotation

Plot	Crops receiving phosphated manure	11-year average increase per acre				Value of increase per rotation
		Corn	Oats	Wheat	Clover	
		Bu.	*Bu.*	*Bu.*	*Lb.*	*Dol.*
32	Corn and wheat, ½ each	16.57	6.95	11.42	1,078	39.59
33	All on corn.....	19.95	8.05	9.44	815	37.46
35	All on wheat	13.83	5.72	13.30	1,259	41.36
36	All on clover.....	15.03	4.16	5.75	1,313	30.66

As in the use of commercial fertilizers the phosphated manure has been applied most profitably to the wheat crop, with an equal division between corn and wheat a close second. The least profitable place in this rotation has been on the new seeding of clover. In a shorter rotation, and in particular in a rotation which does not include wheat, the results might be expected to be quite different.

GROUND LIMESTONE VERSUS HYDRATED LIME MAGNESIUM VERSUS CALCIUM COMPOUNDS

A comparison of finely ground limestone and hydrated lime, in which both high-calcium and magnesian limestones and hydrated limes are included, has been in progress 11 years. All liming materials are applied to corn in a corn-oats-wheat-clover rotation, the amounts used being in all cases chemically equivalent to 2 tons per acre of the high calcium limestone. All plots have received a basic treatment of 8 tons of manure on corn and 480 pounds of acid phosphate on wheat.

TABLE 5.—Neutralizing Power and Fineness of Liming Materials

Liming material	Neutralizing power	Fineness		
		Passing 10-mesh	Passing 50-mesh	Passing 100-mesh
		Percent	*Percent*	*Percent*
High calcium limestone	98.8	100.0	62.0	45.3
Magnesian limestone	106.0	100.0	100.0	97.1
High calcium hydrated	128.5	.....	.....	.....
Magnesian hydrated	160.9	.....	.....	.....

The neutralizing powers and fineness of the materials used are shown in Table 5. Table 6 gives the 11-year average crop yields, the average increases due to liming, and the average value of the increase per acre per rotation.

There are no large differences between the values of the increases produced by the different liming materials, the return for a 1-ton lime-carbonate equivalent varying from $11.40 for the magnesian limestone to $12.48 for the high calcium hydrate.

The hydrated limes have in both cases produced increases of slightly higher value than the corresponding limestones, the difference amounting to 6.7 percent for the high calcium and 8.2 percent for the magnesian compounds. Most of this advantage for the hydrated limes was produced during the first rotation, when the corresponding differences were 23.1 percent in favor of the high calcium hydrate and 23.2 percent in favor of the magnesian hydrate.

In choosing between ground limestone and hydrated lime it would appear that first consideration should be given to differences in the local costs of purchasing, hauling, and applying chemically equivalent amounts of the two forms of lime, assuming their strength to be approximately in proportion to the guaranteed neutralizing values.

TABLE 6.—Yields and Increases from Different Forms of Lime
Ground Limestone vs. Hydrated Lime
Magnesian vs. Calcium Compounds

Plot	Treatment	Yield				Increase				Value of increase
		Corn	Oats	Wheat	Clover	Corn	Oats	Wheat	Clover	
		Bu.	*Bu.*	*Bu.*	*Lb.*	*Bu.*	*Bu.*	*Bu.*	*Lb.*	*Dol.*
14	Magnesian limestone....	66.36	53.71	29.82	4,013	11.88	2.02	3.57	1,110	22.80
17	High calcium limestone..	66.79	55.57	31.14	4,008	11.68	2.68	4.37	1,007	23.36
15	Magnesian hydrated....	67.30	54.93	30.70	4,107	12.41	2.42	4.18	1,160	24.68
18	High calcium hydrated..	68.58	56.65	31.35	3,934	13.51	4.19	4.60	922	24.95
Av.	Ground limestone.....	66.57	54.64	30.48	4,010	11.78	2.35	3.97	1,058	23.08
Av.	Hydrated lime.....	67.94	55.79	31.02	4,021	13.00	3.30	4.39	1,041	24.81
Av.	Magnesian compounds ..	66.83	54.32	30.26	4,060	12.18	2.22	3.88	1,135	23.74
Av.	Calcium compounds.....	67.68	56,11	31.25	3,971	12.59	3.43	4.49	964	24.15

Neither in the case of the limestones nor hydrated limes is there a significant difference between the values of the increases produced by the high calcium and the magnesian limes. The extreme fineness of the magnesian limestone may account for its favorable showing, since other experiments indicate that with more coarsely ground stones a high content of magnesium may considerably retard their rate of action in the soil.

AMOUNT OF LIME PER ACRE

In 1905 a test was begun in which increasing amounts of lime, together with 8 tons of yard manure, were regularly applied to corn in a 3-year rotation of corn, oats, and clover. The oats and clover were untreated. Plot 2 received 500 pounds per acre of calcium oxide as quicklime; Plots 3, 6, and 9 received 1000 pounds of the oxide, respectively, as quicklime, fine ground limestone, and hydrated lime; Plot 5 received 2000 pounds of the oxide as quicklime.

In Table 7 are given the average crop increases for lime obtained by deducting the increases due to manure alone from the corresponding increases due to the combined manure and lime treatments. The table also shows the money value of the crop increases and the cost of the lime, figuring calcium oxide at $10 per ton. The balance was obtained by subtracting the cost of the lime from the

value of the increase. The approximate present reaction of the plot soils was determined upon fresh samples and is stated in pH.

The highest value for crop increases has been obtained on Plot 5, receiving 2000 pounds of calcium oxide and possessing moderate alkalinity as indicated by a reaction of pH 8.2. On the other hand, the balance over the cost of the lime has been slightly higher on the plots receiving 1000 pounds of oxide and which now have a reaction very close to the point of true neutrality, pH 7.0. An application of 1000 pounds of calcium oxide every 3 years is equivalent to 1780 pounds of limestone, or approximately 600 pounds of limestone for each year of the rotation.

TABLE 7.—Amount of Lime Per Acre, Lime and Floats Test

Plot	Calcium oxide per 3 years	Increase over manure alone					Balance	Present reaction
		Corn	Oats	Hay	Total value	Cost of lime		
No.	*Lb.*	*Bu.*	*Bu.*	*Lb.*	*Dol.*	*Dol.*	*Dol.*	pH
2	500	5.86	2.25	574	9.30	2.25	$7.05	6.6
3,6,9	1,000	8.76	2.87	860	13.73	5.00	8.73	7.3
5	2,000	10.98	3.10	1,276	18.50	10.00	8.50	8.2

In 1911 a special lime test was begun which included plots receiving 2, 4, and 8 tons of finely ground limestone in addition to manure and acid phosphate on corn in a 4-year rotation of corn, oats, wheat, and clover. Table 8 gives the average crop increases for the addition of lime above those produced by manure and acid phosphate alone. The value of the increase is also shown, together with the cost of the limestone at $5 per ton, the balance obtained by subtracting the cost of lime from the value of the increase, and the present reaction of the plot soils in pH.

TABLE 8.—Amount of Lime Per Acre, Special Lime Test, Fry Farm

Plot	Limestone per 4 years	Increase over manure and acid phosphate				Total value	Cost of lime	Balance	Present reaction
		Corn	Oats	Wheat	Hay				
No.	*T.*	*Bu.*	*Bu.*	*Bu.*	*Lb.*	*Dol.*	*Dol.*	*Dol.*	pH
2,17	2	12.01	2.27	3.82	1,056	22.96	10.00	12.96	7.1
12	4	14.63	4.32	5.78	1,257	30.07	20.00	10.07	7.7
20	8	8.40	4.36	5.77	1,464	27.26	40.00	−12.74	7.9

The value of the increase has been largest on Plot 12, receiving 4 tons of limestone per acre. This plot is now moderately alkaline as shown by a reaction of pH 7.7. Here again the most profitable increases have been secured on Plots 2 and 17, having at present a reaction very close to true neutrality and receiving 2 tons of lime-

stone every 4 years, equivalent to 1000 pounds per acre per year. Subtracting $10, the cost of 2 tons of limestone, from $22.96, the value of the increase on these plots, gives a balance of $12.96 or $6.48 for each ton of limestone applied.

Table 9 gives the increases produced during successive rotations in this test. The data indicate a considerable cumulative effect from each of the limestone treatments. For example, the values of the increases on Plots 2 and 17 average $16.47 for the first rotation, $24.07 for the second, and $30.54 for the third. These plots have already reached a neutral reaction and the question might be raised whether a smaller application than 2 tons of limestone each rotation may not now maintain the reaction of the soil at this point and result in greater profit.

TABLE 9.—Fry Farm Lime Test by 4-year Periods

Rotation	Plot	Limestone	Increase for lime				Total value	Cost of lime	Balance
			Corn	Oats	Wheat	Clover			
		T.	*Bu.*	*Bu.*	*Bu.*	*Lb.*	*Dol.*	*Dol.*	*Dol.*
1st 4 years	2&17	2	6.47	2.38	2.12	1,041	16.47	10	6.47
	12	4	9.61	5.15	3.48	1,216	23.13	20	3.13
	20	8	13.59	3.67	3.79	1,377	26.98	40	−13.02
2d 4 years	2&17	2	13.64	2.02	4.17	996	24.07	10	14.07
	12	4	14.24	1.20	5.50	1,189	27.82	20	7.82
	20	8	6.69	3.56	6.21	2,124	31.35	40	−8.65
3d 4 years	2&17	2	17.21	2.46	5.64	1,206	30.54	10	20.54
	12	4	21.84	7.37	9.22	1,475	43.13	20	23.13
	20	8	3.74	6.35	7.84	818	22.98	40	−17.02

Plot 20 receives the unusually heavy application of 8 tons of limestone each rotation. This plot gave the largest crop increase the first rotation. In the second rotation the yield of corn was considerably reduced as compared to the lighter limestone applications, altho the clover yield was still superior. In the third rotation the yield of corn was still more seriously depressed and the depression extended to the clover crop. This plot gives the first evidence secured by the Station that crop yields may be impaired by too heavy applications of lime in carbonate form. The true explanation of this effect has not yet been determined. The cause may perhaps be found in either the temporary development of a too alkaline reaction, especially for the corn crop to which the lime is applied, or in the repression of the solubilities of potassium, magnesium, iron, manganese, or other elements required by the crop.

PROGRESS REPORT ON CROP ROTATION TESTS

Eleven years' work has been completed with some 40 different rotations on the Station farm at Wooster. As stated in earlier reports, the average annual treatment of the land is the same in each rotation regardless of its length. This treatment consists of 2 tons of ground limestone per acre every 4 years and an average of 2 tons of stable manure and 200 pounds of 16-percent acid phosphate per acre per year. The manure is applied to the first-year crops, usually corn or potatoes. Every crop in the rotations is grown each year.

In arriving at the average annual crop values per acre corn was valued at 70c per bushel, oats at 40c, wheat at $1.50, potatoes at $1.25, soybeans at $2, clover and timothy hay at $15 per ton and alfalfa hay at $20. Where these prices do not fit they can be adjusted to local conditions.

A Second Crop of Corn Versus Oat

The value of a second crop of corn in comparison with oats is measured in two 4-year rotations, 21 and 23, and in two 5-year rotations, 31 and 33, as found in Table 10. The other crops of the rotations are corn, wheat, and clover, with a year of timothy in the 5-year rotation. In the 4-year rotations the substitution of corn for oats added $2.46 to the average annual gross value of the crops, and in the 5-year rotations $1.57—surprisingly little differences. This seems to be due mainly to the larger yields of wheat following oats than corn, an average difference in these rotations of a little over 7 bushels per acre. There is of course larger expense in growing wheat after oats, as also a larger expense in growing a crop of corn than of oats.

One, Two, or Three Crops of Corn in a 5-year Rotation

These comparisons are found in rotations 31, 33, and 38. In each the first crop of corn gets 10 tons of manure and 200 pounds of acid phosphate per acre; the other corn crops get 400 pounds of acid phosphate.

The gain in crop values for two crops of corn as compared with one is $1.57 per acre, and for three as compared with two is $2.50. These gains would hardly compensate for the additional expenses.

More Hay in the Rotation

Facts bearing upon this question are found in rotations 32, 38, and 40 where three crops of corn are compared with three crops of hay in 5-year rotations. With clover and timothy hay valued at

$15 per ton and alfalfa at $20, which seem to be about right for Ohio conditions, the rotation with the extra corn crops exceeds the timothy rotation in average annual value by $2.92 per acre, and is $4.64 behind the rotation with three crops of alfalfa. If the corn borer gets in its expected work in Ohio it will likely be necessary to reduce the corn acreage and increase that of legumes.

TABLE 10.—Crop Rotations, Yields and Average Annual Values Per Acre

No. of rotation	Length of rotation	Crops in order grown	Yield	Average annual value
21	4	Corn Oats Wheat Clover	67.69 bushels 65.19 bushels 34.82 bushels 1.86 tons	$38.40
23	4	Corn Corn Wheat Clover	74.95 bushels 57.85 bushels 29.20 bushels 1.78 tons	40.86
24	4	Corn Potatoes Wheat Clover	75.07 bushels 110.37 bushels 35.77 bushels 1.88 tons	68.09
27	4	Corn Soybeans Wheat Clover	71.15 bushels 15.50 bushels 30.83 bushels 1.57 tons	37.66
31	5	Corn Oats Wheat Clover Timothy	68.53 bushels 63.87 bushels 37.15 bushels 1.71 tons 1.99 tons	36.95
32	5	Corn Wheat Clover Timothy Timothy	73.11 bushels 33.39 bushels 1.99 tons 2.07 tons 2.03 tons	38.52
33	5	Corn Corn Wheat Clover Timothy	73.15 bushels 60.93 bushels 28.59 bushels 1.76 tons 2.01 tons	38.66
38	5	Corn Corn Corn Wheat Clover	70.78 bushels 63.17 bushels 58.43 bushels 31.11 bushels 1.63 tons	41.16
40	5	Corn Oats Alfalfa Alfalfa Alfalfa	73.42 bushels 64.99 bushels 2.25 tons 2.45 tons 2.88 tons	45.80

Oats, Corn, Potatoes, and Soybeans as 2d-year Crop in 4-year Rotations

In rotations 21, 23, 24, and 27 oats, corn, potatoes, and soybeans are compared as second-year crops in 4-year rotations which include corn, wheat, and clover. Aside from the rotation including potatoes, the differences in average annual values are not great. Not

only is the potato crop the most valuable one of the group, but the associate crops of corn, wheat, and clover all yield higher in the potato rotation than in the others. Wheat is lowest in yield following corn, and clover lowest in the soybean rotation. At the crop valuations indicated the relative value of the four crops compared as grown in these rotations is, potatoes, first; corn, second; soybeans, third; and oats fourth, tho the oat rotation as a whole is slightly more valuable than the soybean rotation.

FLAX AND CEREAL MIXTURES

In Canada and parts of the spring-wheat area in the United States, larger total yields of grain are frequently secured by a mixture of spring cereals and flax than with the single crop. The publicity given to this practice is causing some Ohio farmers to consider the advisability of trying such mixtures. In order to get information on this point, the Station started a test in 1923 in which several combinations of crops were grown. Table 11 gives the 3-year average results to date.

TABLE 11.—Flax and Cereal Mixtures, Wooster

Seeding rate per acre	Yield per acre		Digestible nutrients		Grain			
	Grain	Straw	Crude protein	Carbohydrates and fat x 2.25	Wheat	Barley	Flax	Oats
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Oderbrucker barley, 2 bu.	1,482	2,352	133.4	1,043.3	.....	100	.....	.....
Oderbrucker barley, 1 bu. } Fulghum oats, 1 bu. }	1,607	2,560	149.5	1,063.3	.....	56.37	.....	43.63
Oderbrucker barley, 1 bu. } Marquis spring wheat, 1 bu. }	1,342	2,358	121.9	947.0	42.65	57.35	.....	.....
Fulghum oats, 2 bu.	2,150	2,663	208.5	1,303.9	.....	.....	.....	100
Marquis spring wheat, 2 bu.	1,340	2,373	123.3	948.7	100.	.....	.....	.....
Fulghum oats, 1 bu. } Flax, ¼ bu. }	1,720	2,800	185.9	1,079.9	.....	.....	10.18	89.82
Oderbrucker barley, 1 bu. } Flax, ¼ bu. }	1,498	2,478	150.1	1,068.9	.....	91.21	8.79	.....
Marquis spring wheat, 1 bu. } Flax, ¼ bu. }	1,081	2,222	118.3	782.4	84.74	.....	15.26	.....
Marquis spring wheat,* 1 bu. } Fulghum oats, 1 bu. }	1,057	1,632	99.3	705.6	59.97	.....	.....	40.03
Flax, ½ bu.	950	2,710	195.7	781.4	.....	.....	100	.....

*Two years only, 1923 omitted.
†Calculated from Table 3. Feeds and Feeding, Henry and Morrison.

The varieties of barley and oats used in this test are the ones that have given the highest yield in variety tests at the Station. Fulghum oats and Oderbrucker barley ripen at about the same time and, therefore, are ideal varieties for growing together. Marquis spring wheat is used because seed of this variety is readily available on the market and is likely to be the one that Ohio farmers would secure. The flax used is Linota, a high seed-yielding variety from North Dakota.

In this test, oats outyielded barley, and spring wheat yielded much lower than either oats or barley. This is in agreement with previous tests on the Station farm at Wooster and on nine outlying test farms in the State, as reported in the 42d Ann. Rpt., p. 17-18.

Oats alone produced more grain, more digestible crude protein, and more total digestible nutrients than any other crop grown singly or in combination. The yields of grain were in the following order: oats, oats and flax, oats and barley, barley and flax, barley, barley and spring wheat, spring wheat, spring wheat and flax, spring wheat and oats, flax.

The yields of total digestible nutrients in order were oats, oats and flax, barley and flax, oats and barley, barley, spring wheat, barley and spring wheat, flax, wheat and flax, wheat and oats.

Altho three years may not be long enough on which to base conclusions, the indications are that a high yielding variety of oats will give a larger return to the acre under our conditions than any mixture of cereals and flax.

VARIETY CORN TEST, PROGRESS REPORT

Medina Pride heads the list in average yield of shelled corn per acre to date, in the variety tests started in 1919. It is also the highest yielding variety tested at the Station for the last 20 years. This is a pale yellow dent variety, originated in Medina County 40 years ago from the Kindig, a local variety of rather flinty type.

Woburn's Yellow Dent is second highest in the list. It is a deep yellow dent corn originated in Champaign County. It is a little later in maturing than the Medina Pride and the yield of stover is greater.

Varieties having a shrinkage of more than 20 percent are too late maturing to be relied upon at this latitude for grain production, as there is too much soft corn when the growing season is short. In general, the later varieties have yielded the larger amount of stover per bushel of shelled corn. The shrink of ear corn from husking time in the fall to shelling time the next spring, as given in Table 12, indicates roughly the maturity of the corn in the fall; the more moisture in the fall, the greater the shrinkage by spring.

The influence of Lake Erie in lengthening the growing season should be taken into account in selecting a variety for the northern edge of Ohio. Leaming corn from Lake County bordering the Lake required as long a growing season as the same variety from Clinton County in southern Ohio.

The average yields per acre for the 6 years, 1919-1924, are given in Table 12. These yields are expressed as bushels of dry shelled corn the following April or May.

TABLE 12.—Corn, Varieties and Source of Seed, 6-year Average 1919-1924

Variety	Seed from	Grain per acre	Shrinkage by spring	Stover per acre	Stover per bushel
		Bu.	*Pct.*	*Lb.*	*Lb.*
Medina Pride	Medina Co.	67.55	15.92	3,348	49.56
Woodburn's Yellow Dent	Champaign Co.	66.14	18.50	3,523	53.26
White Cap	Wayne Co.	66.04	14.36	3,230	48.91
Clarage (Wooster)	Wayne Co.	65.65	16.90	3,214	48.96
Ohio No. 84 (Wooster)	Wayne Co.	65.59	16.92	3,120	47.51
Leaming	Lake Co.	65.56	20.42	3,583	54.65
Cook's No. 75	Hardin Co.	65.20	21.56	3,897	59.77
Leaming	Clinton Co.	63.21	20.18	3,438	54.39
Darke County Mammoth	Darke Co.	61.49	22.68	3,731	60.68
Silver King	Portage Co.*	58.50	16.50	2,965	50.68
Reid's Yellow Dent	Fayette and Madison Co.	57.58	27.50	4,687	81.40
Golden Glow	Wisconsin*	57.55	15.92	2,740	47.61
Pride of the North	Nebraska*	56.78	16.80	3,425	60.32
Minnesota No. 13	Minnesota	55.32	13.08	2,600	47.00
Longfellow Flint	Various sources	50.05	13.18	2,803	56.00
Boone County White	Kentucky*	46.75	33.33	6,470	138.39

*Occasionally seed obtained from other sources.

Many of these varieties have been tested for more than the 6 years reported in the table. Others under test for a shorter period will be reported later.

GERMINATION OF EARLY HARVESTED SEED CORN

In 1924 seed corn was harvested at five stages as follows: blister stage, early milk stage, full milk stage, early dough stage, and late dough stage. This seed was stored in a warm dry room and germination tests were made during the winter.

Seed harvested in the blister stage yielded few live sprouts and all were very weak. The germination of seed harvested in the early milk stage was 38 percent, and nearly half of the kernels that germinated produced very weak sprouts. Beginning with the full milk stage, far better results were obtained. This harvest was between three and four weeks after the exposure of the silks just a little before the corn was ready for roasting ears. The percentage of germination was above 95. The sprouts were somewhat slower than those from mature kernels but fairly satisfactory growth was obtained from similar seed planted in 1925.

Except for noticeably more vigorous sprouts, grain harvested in the early dough and late dough stages gave results on the germinator practically identical with that harvested in the full milk stage. The early dough stage corresponds to prime roasting ear stage. In

the late dough stage kernels are beginning to dent. Seed harvested in either of these two stages produced wholly satisfactory results both on the germination and in field plantings.

Selecting seed corn at these early periods is of course not to be recommended as a general practice, but in case of emergency the corn grower need not hesitate to gather corn for seed as early as the roasting ear stage. It must be emphasized, however, that disappointment will very probably follow such a procedure unless favorable storage conditions are provided.

PASTURE IMPROVEMENT

In the beginning of the general trade in fertilizers in the late 70's, comparatively few crops were fertilized; but their use has since extended to practically all cultivated farm crops. The use of fertilizers on pastures has lagged behind their use on other crops, probably for two reasons:

In the first place, pasture grasses remove from the soil a comparatively small amount of fertilizing constituents. For example, an annual 2-ton crop of blue grass each season would remove in the course of four years approximately 70 percent as much nitrogen; 25 percent as much phosphorus and 50 percent as much potassium as would the crops in a four-year rotation of corn 75 bu., oats 75 bu., wheat 30 bu., and clover 2 tons.

In the second place, a large proportion of the fertility contained in pasture grass is, by the nature of the case, returned directly to the soil. However, the gradually diminishing yield of nutritious grasses and the ever increasing number of noxious weeds, such as yarrow, daisies, thistles, ragweeds, etc., are mute evidences of the gradually declining fertility of pasture land. The time, therefore, is at hand in many sections of Ohio when the use of fertilizer is as necessary for the production of good pasture as for the raising of cultivated crops.

An experiment to determine the kind of fertilizers needed in an old pasture was started at the Ohio Experiment Station in the spring of 1924. A tract of gently rolling, naturally drained, land in an old, pasture on the Hindman farm, was selected for the experiment. The stand of grass was thin and in places moss and sorrel predominated. Yarrow was plentiful everywhere. The field had been plowed and cropped to corn and wheat two or three times in its history. Each time it had been seeded down after two or three years of cropping. At the time this pasture experiment was started, it had been in pasture about seven years.

The land was divided into ten one-twentieth acre plots each 16 by 136 feet. A space 4 feet wide was left between each two plots. On May 1, 1924 the plots were treated as indicated in the accompanying table, every third one being left untreated to serve as a check. In the summer of 1924 the plots were not pastured and no yields were obtained. From observation, it was not possible to detect any difference in the amount of growth made by the grass. The yarrow flourished on all the plots.

On May 26, 1925 all the plots were clipped with a mowing machine and the debris removed. On three subsequent dates, June 3, June 30, and August 24, all the plots were clipped with a lawn mower. The green weights obtained on each date and the total for the season are shown in Table 13.

TABLE 13.—Pasture Test on Hindman Farm, Wooster, 1925

Plot	Treatment	Green weight in pounds per acre			
		June 3	June 30	Aug. 24	Total
1	Nothing	1005	360	477	1842
2	Acid phosphate, 400 lb	1055	390	542	1987
3	Limestone, 2 tons	1357	440	762	2559
4	Nothing	1270	480	587	2337
5	Acid phos., 400 lb., limestone, 2 tons	1612	342	535	2489
6	Acid phos., 400 lb., mur. of pot., 100., limestone, 2 tons	2020	327	607	2954
7	Nothing	1200	337	552	2089
8	Acid phos., 400 lb., mur. pot., 100 lb., nitrate soda, 100 lb., limestone, 2 tons	1927	470	565	2962
9	Acid phos., 400 lb., nitrate soda, 100 lb	1715	492	545	2752
10	Nothing	1130	462	635	2227

The highest yield was obtained on Plot 8 where all four materials were used; the second highest on Plot 6, the treatment of which was the same as Plot 8, except that it received no nitrate of soda; and the third highest yield was obtained on Plot 9 which received acid phosphate and nitrate of soda only.

At each cutting an estimate of the proportion of clovers was made. Limestone alone did not materially increase the growth of the clovers. However, acid phosphate alone and all the combinations used resulted in the bringing in of a considerable sprinkling of white clover, the most pronounced effects being on Plots 5, 6, and 8.

At the beginning of the experiment two additional plots were included on both of which a mixture of seeds was sown and harrowed in. One of these plots was fertilized; the other was not. The mixture sown on the unfertilized land produced no improvement; that sown on the fertilized plot increased the proportion of red and alsike clovers.

APPLE SCAB STUDIES

A study of the complete life cycle of the scab organism, with special emphasis on the effects of weather conditions, was continued in 1925.

In the main, the disease was not difficult to control, during the season and in some sections it was not necessary to spray for scab. There was very little rainfall during the spring months and, consequently only a very limited number of spores were matured. The accompanying graph shows the relation of the amount of rainfall and spore discharge during the past two seasons.

It will be noted that spore counts made in 1924 showed a heavy discharge during the rainy period of May 4 to 20. Under these conditions the disease could not be controlled except when sprays were timed for those heavy spore discharges.

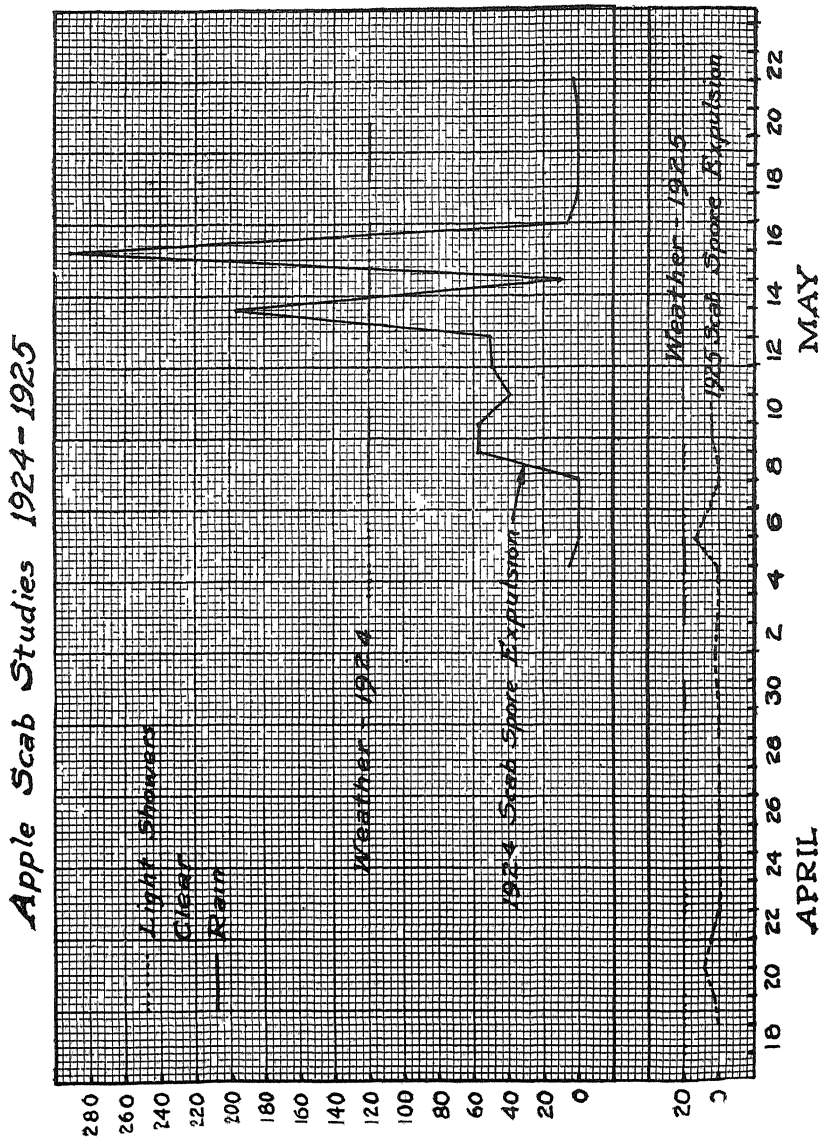
In 1925 conditions were quite the reverse. There was very little rain and only slight spore discharge. Unsprayed trees in many plots had less than 2 percent scabby apples.

Tho rain fell May 18, 1924, there was but little scab spore discharge owing to the fact that the perethecia had become exhausted. On the other hand, in 1925 there was not enough rain to mature spores for initial infection.

In the two years there was sufficient evidence to prove the necessity of timely spraying and that the initial infection may take place as soon as the buds open or even before the application of the so-called delayed dormant spray. Moreover, it was found that this very early infection is responsible for later fruit infection and is at all times difficult or impossible to reach with spray materials.

This point was proved in an experiment conducted at the Aplink orchards in 1925. One block of McIntosh was sprayed with oil in delayed dormant, and subsequent applications were made with 300-mesh sulphur dust. At the end of the season, there were 11.6 percent scabby leaves. Another block of the same variety was sprayed with soluble sulphur in delayed dormant, and subsequent applications were made with 300-mesh sulphur dust. This block gave 2.5 percent scabby leaves.

The spray service then emphasized the following points: 1. Timeliness of spraying, gaged by spore discharge. 2. The necessity of controlling initial infection. 3. Expense of spraying can vary with rainfall, the latter governing initial infection. 4. The need for a general spray service.


Apple Scab Studies 1924-1925
Light Showers
Clear
Rain
Weather - 1924
1924 Scab Spore Expulsion
Weather - 1925
1925 Scab Spore Expulsion
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
20
0
18 20 22 24 26 28 30 2 4 6 8 10 12 14 16 18 20 22
APRIL
MAY

BLOTCH CONTROL EXPERIMENTS

The relative value of bordeaux mixture and liquid lime-sulphur in the control of apple blotch in southwestern Ohio was tested in the Augspurger orchard at Middletown, Ohio. This orchard had not been sprayed for a number of years and the trees of the susceptible varieties, were thoroly infected with the causal fungus, *Phyllosticta solitaria*. Because of abundant infection the orchard was particularly well suited for the comparative tests, which were conducted in cooperation with the Bureau of Agriculture of the Middletown Civic Association.

Ben Davis, a variety which blotches very badly, was used in the tests. The orchard also contained Flora Bellflower, Tompkins King, Wealthy, Duchess of Oldenburg, and York Imperial. The branches interlace, making an ideal condition for the spread of disease producing organisms.

In the test 40 trees were sprayed with lime-sulphur 1-40; 20 with bordeaux 2-2-50, except in the mid-summer when a 3-3-50 strength was used; 6 trees were left unsprayed as checks.

Six sprays, the pink, petal-fall, 2-, 4-, and 6- weeks, and midsummer were given. An insecticide was added whenever the regular program called for it.

The check trees received arsenate of lead in the petal-fall, 2-weeks, and midsummer sprays, as it has practically no value in blotch control, but aids materially in securing a fair crop on the check trees.

The fruit was picked and counted Sept. 9 and 10, representative trees being selected for the counts, with the following results.

TABLE 14.—Bordeaux and Lime-sulphur in Blotch Control, 1925

Treatment	Free from blotch	Slightly blotched	Badly blotched
	Percent	*Percent*	*Percent*
Check	7.3	9.2	83.5
Lime-sulphur	71.5	21.8	6.7
Bordeaux	99.4	0.6	0

Under the conditions of the experiment bordeaux gave considerably better control of blotch than lime-sulphur. From the results of two years tests it would seem unadvisable to use lime-sulphur for the cleaning up of blotch in a badly infested orchard. It was further found that the effectiveness of lime-sulphur depends upon the time of blotch infection. When the infection was early, as in 1924, lime-sulphur was very efficient, especially where the 2-, 4-, and 6-weeks sprays were applied. On the other hand, when the

infection was late, lime-sulphur was less effective, due, undoubtedly, to the long period between the 6-weeks and second codling-moth spray. The results of this work indicate that lime-sulphur may be effective against blotch, if cognizance is taken of the infection period, which is entirely regulated by weather condition.

Lime-sulphur was not effective in the control of bitter rot. Copper dusts gave promise in its control.

PEACH DISEASE CONDITIONS IN OHIO

An extensive study of peach diseases was made during the past season. There had been very little research done on this in Ohio and, as a result, the growing of the fruit has been a decidedly uncertain risk. Spraying had been only spasmodic, resulting in a gradual increase of peach diseases. Moreover, there was considerable uncertainty of the identity of many of the causal organisms.

A definite spray program has been perfected. Results show that for summer treatment sulphur dusts may be substituted for the liquid spray with practically equal control.

Another phase of this study is with peach twig cankers. Fruit growers for years have noted dying of twigs with a general reduction in vigor of the trees. Aside from winter killing, canker lesions, whatever their cause, are perhaps the most troublesome of peach-bark diseases. Apparently, cankers are found to some extent in all orchards. In some their presence seems to overshadow all other diseases. Several possible causes have suggested themselves: 1, winter killing, in the form of cankers; 2, the brown-rot fungus; 3, the bacterial black-spot organism; 4, the pustular spot, or California peach-blight fungus; 5, the die-back fungus; 6, spray injury.

While the cause of most of the cankers of peach has been attributed to winter injury, our work disproves this theory.

THE BROWN-ROT FUNGUS AND CANKER

In a survey of orchards affected with these cankers, a striking resemblance was noted between these lesions and those described from New York State as due to the brown-rot fungus, *Sclerotinia cinerea*. Hundreds of specimens of various sizes gathered from several sources, showed brown rot in approximately two-fifths of the plantings. In the remainder nothing developed indicating that the fungus had died out, and by making inoculations in healthy twigs, the typical canker was produced. All the cankers observed showed a wound of some type, such as pruning wound or dead twigs, as a center where the causal agent obviously entered.

BACTERIUM PRUNI AND PEACH CANKER

The black spot of peach and plum caused by *Bacterium pruni* is somewhat general in Ohio, altho its frequent damaging nature seems yet to be demonstrated. On the fruit it seems to be confused with the California peach blight, or pustular spot; on the leaves, spots produced by arsenate of lead are often mistaken for black spot; on the twigs, the small lesions produced by such agencies as arsenicals, the brown-rot fungus, the California peach-blight fungus, and even the scab fungus, are all, at times, mistaken for the work of *Bacterium pruni*. The last named organism, however, is present in Ohio, but much of the twig and limb trouble commonly attributed to it by growers is probably due to other causes. In the several hundred isolations, this organism appeared only twice.

The following suggestions will be helpful in controlling disease:

1. Practice a complete spray schedule with timely, effective spraying.
2. In pruning, cut the twigs and limbs as close to the parent branch as possible, making the face of the cut parallel to the main axis of the parent branch; leave the cut surface smooth and cover with a standard wound dressing, such as gas tar or liquid asphaltum. (See Ohio Exp. Sta. Cir. No. 126 and 150.)
3. From the standpoint of winter injury, unusual practices in cultivation and fertilization should be avoided. Prolonged cultivation and excessive fertilization tend to keep the tree active at a time when it should be hardening in preparation for winter.

SPRAYING AND DUSTING POTATOES

Since the appearance on the market of copper-lime dusts for dusting potatoes, there has been much controversy regarding the relative benefits of dusting and spraying. Spraying potatoes with bordeaux mixture is a sound and profitable practice; dusting seems to be the practice in question.

In the plots at Wooster in 1925 no late blight developed. Some early blight appeared but not to the extent that appreciable injury was done. Hopper burn was evident, hence, the benefits of a treatment were due largely to its control and to plant stimulation.

Results of Spraying and Dusting Potatoes

Treatment	Yield, bushels	Increase, bushels
Check, no treatment	212.1	——
4-6-50 bordeaux, 4 sprays	265.9	53.8
5-7-50 bordeaux, 4 sprays	264.9	52.8
Copper dusts, 4 applications	278.2	66.1

The potatoes were planted May 13. The first treatment was put on 6 weeks later, and the successive treatments followed approximately every 2 weeks. A hand dust gun was used to apply the dusts and a power sprayer for the application of the bordeaux. Arsenate of lead was used to guard against injury from chewing insects.

All the treatments produced a considerable increase over the checks. A 4-6-50 and a 5-7-50 bordeaux proved equally effective. The copper-lime dusts produced a greater increase than either of the sprays. In 1924 the increase due to dust was only 44.6 percent as great as the increase due to liquid bordeaux. The inconsistency of different tests at this and other stations, coupled with the fact that we have not yet had an opportunity to observe the efficiency of dust in controlling late blight, leaves potato dusting in the experimental stage. Further tests must be carried out before safe and final conclusions can be drawn. It is a procedure, however, that shows promise.

FURTHER STUDIES WITH POTATO DEGENERATIVE DISEASES

That the infectious particles which cause potato degenerative diseases may not be present in every tuber, or every eye of every tuber, from a diseased hill was shown by plants grown in the greenhouse during the past winter. Mosaic and healthy plants were grown from different tubers of the same hill. Likewise, mosaic and what appeared to be healthy plants were grown from different eyes of the same tuber.

Hills affected with leafroll, one of the main causes of potato "run out" in Ohio, were found to yield only 38.9 percent as much as healthy hills. Mild mosaic, which we detect only occasionally in Ohio potato fields, reduced the yields of affected hills to 90.8 percent that of healthy hills. The severe or rugose type of mosaic, however, cut the yield down to 33.1 percent that of healthy hills.

Since all potato degenerative diseases are seed borne, these figures are a convincing argument that only disease-free seed should be planted.

BROWN PATCH DISEASE OF GRASS

A disease known as "brown patch" caused severe injury to the grass of many lawns and golf greens during the year. The disease appears in periods of hot weather when the humidity is high. The infected areas may be from 4 inches to 2 feet in diameter. The grass within a freshly infected area early in the morning has a dark,

water-soaked appearance. Numerous, fine, white cobweb-like mycelial threads weave a network from one grass blade to another. Later in the day, when the grass has dried off, it takes on a browned appearance and the network of mycelium disappears. The mycelium is a part of the fungus *Rhizoctonia solani* which causes the disease.

The brown patch fungus attacks the grass above ground only; therefore, if the fungus is checked, the grass roots will send up new growth. Fungicides composed of chlorophenol-mercury compounds, known by the trade names, Uspulun and Semesan, were applied to a badly infected lawn at Canton. A 1-300 strength solution was applied at the approximate rate of ½ gallon to 1 square yard of lawn. The morning following application, it was evident that the spread of the fungus had been checked. Within a month practically all of the diseased areas were healed over with a new growth of grass and were green again.

CONTROL OF BUNT OR STINKING SMUT OF WHEAT

One purpose of these tests involving the control of stinking smut of wheat with fungicides used as a dust, was to give the treatments as severe a trial as possible. It was also thought desirable to make trials of other compounds which can be produced at lower cost than copper carbonate and which can be adapted for use in the dust form. A few proprietary compounds were also included.

TABLE 15.—Result of Dust Treatments for Control of Bunt of Wheat

Treatment in ounces per bushel	Percent of smut
Average of checks, untreated	29
Copper carbonate (Corona brand) 2 oz.	1.5
Copper carbonate (Corona brand) 3	.5
Copper carbonate (pure) 2	.5
Copper carbonate (pure) 3	.0
Copper sulphate 2	trace
Copper sulphate 3	trace
Copper stearate 2	trace
Bordeaux mixture (11 percent copper) 3	trace
Du Pont No. 12 3	trace
Du Pont No. 16 3	.0
Nickel chloride (Anhydrous)	1.2

All of the compounds presented in the table gave satisfactory commercial control of the stinking smut disease of wheat. There is strong indication that copper sulphate used as a dust will prove more satisfactory than copper carbonate. Anhydrous nickel chloride takes up moisture from the air so rapidly that the grain becomes nearly as moist as in the case of formaldehyde treatment.

For this reason this preparation is not likely to gain favor altho it gives promise of being satisfactory as a fungicide against seed-borne diseases.

CONTROL OF OAT SMUT WITH DUST TREATMENTS

The excellent control of both covered and loose smuts of oats with fungicides in the powder or dust form during the season of 1924 encouraged a continuation of the work. Later results have fully warranted this continuation. None of the copper salts used alone controlled oat smut, neither did mercuric chloride seem to possess marked fungicidal value when reduced to half strength by combining with an inert kaolin filler. On the other hand, when one part of any of the copper salts used—copper sulphate, copper acetate, and copper carbonate—was combined with two parts of mercuric chloride, the resulting mixture was found to possess a high fungicidal efficiency. Copper acetate combined with the mercury salt has always given best control of oat smut. This was followed closely by copper sulphate.

TABLE 16.—Smut Control and Yields Following Different Treatments upon Oats. All treatments used at the rate of 3 oz. per bushel

		Percent of smut	Yield bushels per acre
1	Average of untreated plots	25	29.3
2	Copper carbonate, 1 part Mercuric chloride, 2 parts	3	41.3
3	Copper carbonate 1 Mercuric chloride 2 1 part+filler 1 part	15	28.8
4	Copper carbonate 2 Mercuric chloride 1	7	32.0
5	Copper carbonate 1 Mercuric chloride 2	2	44.2
6	Copper sulphate 1 Mercuric chloride 2 1 part+filler 1 part	13	37.8
7	Copper sulphate 2 Mercuric chloride 1	5	40.6
8	Nickel carbonate 1 Mercuric chloride 2	3	42.0
9	Nickel carbonate 1 Mercuric chloride 2 1 part+filler 1 part	10	44.6
10	Nickel carbonate 2 Mercuric chloride 1	4	41.0
11	Copper acetate 1 Mercuric chloride 2	1	37.4
12	Copper acetate 1 Mercuric chloride 2 1 part+filler 1 part	19	36.6
13	Copper acetate 1 Mercuric chloride 2	9	41.3
14	Copper stearate 1 Mercuric chloride 2	11	38.2
15	Copper stearate (pure)	22	34.6
16	Mercuric chloride 1 Filler 1	29	32.2
17	Bayer dust	25	33.2
18	Nickel chloride (anhydrous)	2	37.7
19	Formaldehyde (dry method)	0.5	41.0
20	Formaldehyde (sprinkling method)	0.6	42.0

The results strongly indicate that the copper and mercury salts have greatest efficiency as dusts when used in combination, and then only when the proportion is respectively one of the copper salt to two of the mercury. Any attempt to change the proportion or to adulterate the mixture by the introduction of inert fillers always resulted in a decided lowering of the fungicidal value of the original mixture.

Reference to Table 16 will show that some of the combinations employed apparently stimulated the development of the smut. It is also apparent that little correlation can be made between percentage of smut and yield of grain. Yet, in all cases where an efficient fungicidal mixture was used, there was a marked increase in yield of grain over the check plots.

EARLY CABBAGE RESISTANT TO YELLOWS

As a result of the rapid spread of the cabbage yellows disease involving serious losses in the Marietta truck section in 1920 and 1921, the departments of Botany and Horticulture cooperating started a project for the development of a selection of early cabbage resistant to the yellows disease and suitable from the standpoint of type and earliness to meet the requirements of truck growers in southern Ohio. The most promising selection was made in 1922 from a planting of Burpee's Early Forcing. The plots of this season showed a high degree of resistance, less than 2 percent of the plants being diseased, altho growing in sick soil. Further selections will be required for the purpose of obtaining strains true to type and to meet market demands.

CANADA THISTLE

An intensive study has been made of Canada thistles in connection with Ohio weed investigations. The study covered the time and place of the first appearance of the weed in Ohio as reported, the life history, extent of seed production, variability, distribution and abundance, uses, natural enemies both insect and fungous, and the most efficient methods of eradication. It was found that these thistles can be exterminated by means of persistent and repeated cutting below the surface of the ground, clean cultivation, smother crops, and chemical sprays.

THE EUROPEAN CORN BORER

Because of the steady increase in European corn borer infestation in Ohio and the severe losses caused by it in Canada, the scope of the control work has been greatly increased. The plan of work, however, has not been changed. Its prosecution has been greatly

facilitated by the continued cooperation of the Federal Bureau of Entomology, the Department of Agricultural Engineering of the Ohio State University, and the Department of Agronomy with the Department of Entomology.

Nearly 250 fortieth-acre experimental plots of corn were grown in Lucas and Sandusky Counties in 1925. The purpose of these seasonal and varietal plantings, as outlined in 1923, was (1) to test varietal resistance to damage, and (2) to establish, if possible, a planting date which will insure maximum yield with a minimum of infestation and damage. An attempt is being made to test all promising varieties and also to develop new varieties which, it is hoped, may meet the requirements of the situation. While some of the fourteen varieties tested in 1925 are promising, the results were not conclusive.

Further experiments designed to determine the degree of efficiency of plowing under standing stalks and stubble as a dependable control measure are still in progress. Technical studies of the behavior of the moths and larvae in the field and under laboratory conditions are being conducted with especial reference to meteorological conditions. In order to avoid duplication, the plowing experiments are being done in cooperation with the Federal Bureau of Entomology.

Before research work had gone far it was noted that the length of stubble remaining on the field after the corn had been cut is an important factor in the control of this pest. It is deemed important that the corn be cut just as low as possible. Therefore, the Department of Agricultural Engineering at the Ohio State University in cooperation with the others engaged in the work, is devising an apparatus, which, when attached to corn binders, will enable us to cut corn within one or two inches of the ground. This device has already met with experimental success.

THE MEXICAN BEAN BEETLE

The distribution of the Mexican bean beetle in Ohio did not extend into widely new territory in 1925, and the central and northern parts of the State are still free from destructive infestation. No parasites or predators of importance were found.

The tick trefoils, *Meibomia canescens*, serve as a wild host for all stages, while other wild legumes are attacked to a less extent. No cultivated varieties of beans have been found more resistant than others, altho some immunity was gained in some plantings due to the relation of the growth of plants to the development of the

insect. Many new insecticide mixtures were tried, but none proved as effective as the dusts recommended in the Bimonthly Bulletin page 203, Nov.-Dec., 1924.

SAN JOSE SCALE AND EUROPEAN RED MITE

The experiments with dormant sprays for the control of San Jose scale and European red mite were continued. The chief purpose of the year's work was to determine the comparative value of the dry lime-sulphur and various oil sprays. The dry lime-sulphur, as in former tests gave satisfactory control of scale, but did not control red mite. The latter was destroyed by application of oil sprays at strengths recommended for scale control, except in engine oil emulsion which requires a strength of 3 percent instead of 2 percent emulsion. Five year's continuous use of Scalecide at standard dormant strength has produced no ill effects on healthy, bearing apple trees.

TOLERANCE OF CONIFERS TO INSECTICIDES

One year's work indicates that conifers are tolerant to a surprising degree to applications of standard strength dormant sprays in the spring before growth starts. Because of the success of these preliminary tests, the work will be enlarged and continued.

THE APPLE IN GRASS-MULCH AND TILLAGE

Orchards at Wooster, and in Washington, Clermont, Belmont, and Hamilton Counties have been planted for the purpose of determining the relative merits of the grass-mulch and tillage-cover crop systems of orchard management. Other factors are involved than those indicated in the mere names of the treatments. Topography of the land, susceptibility to erosion, and ease of orchard operation are some of the matters to be considered.

In the main there has not been a striking difference in growth of trees in the two systems, altho the tilled trees will average slightly ahead at the end of eight to ten years. Yield is also a little heavier, sometimes considerably heavier, in the tilled blocks even tho the mulched trees might start bearing first. The cost of management is less in the mulch than in the tilled areas.

From the orchard at Wooster, planted in 1915, assuming the trees to be set 40 feet apart each way, and using the results secured in this orchard as a basis of calculation, the cost of growing an acre of orchard and the income derived therefrom the first 10 years would be as follows:

	Cost per acre	Income per acre
Cover-crop system	$153.63	$175.77
Grass-mulch system	90.45	186.57

This does not take into account picking and grading costs, land rental, or supervision.

Much of the fruit produced during the period was borne on the lower limbs of the trees. The trees were headed low and this was no doubt a factor in getting good yields.

The results show that the grass-mulch plot has been grown more economically than the cover-crop plot. They also indicate that production under the grass-mulch system is as satisfactory as under the cover-crop system. However, experience at the Station and elsewhere shows that the grass-mulch system should be supplemented with nitrogenous fertilizers to obtain maximum yields.

APPLE SCAB AND APPLE BLOTCH

The spraying experiments for the control of apple scab and apple blotch at the Southeastern Test Farm and in the leased Perine orchard in Washington County have produced their third season's results. The outstanding lesson of these experiments is that both apple scab and apple blotch can be successfully controlled by much weaker spray mixtures than ever were used previous to the beginning of these tests, provided the spraying be done carefully and thoroly. Bordeaux sprays of one-fourth to one-thrid the formerly recommended strengths gave as satisfactory control of these diseases as the more concentrated and expensive formulas, and with greatly lessened injury to fruit and foliage.

The lime-sulphur sprays, both from the commercial solution and from the dry or powdered form, continued to show superior fungicidal properties and a tendency to develop apples with a smoother and more glossy finish than is possible with the more caustic and actually dangerous copper sprays. The lime-sulphur sprays again gave excellent control of apple blotch.

Tests of the 9-50 hydrated-lime solution indicated that the lime spray possesses from one-half to three-fourths the fungicidal possibilities of bordeaux mixture or lime-sulphur solution. When the copper sulphate was eliminated from the bordeaux formula of 3-9-50, the remaining lime solution of 9-50 gave 50 to 75 percent as complete control of fungi as the original bordeaux mixture.

FERTILIZING THE PEACH

The peach ranks second to the apple in interest to Ohio orchardists, there being about half as many trees of the former as the latter, according to the last census. The county having the largest number of trees is Ottawa, altho there is considerable development in other sections. This interest has led the Station to undertake some additional work to determine certain points regarding the fertilizer requirement of this fruit.

It has been known for some years that the peach responds readily to manures or commercial forms of nitrogen, but not much to phosphorus, potassium, or lime. Some slight exceptions to this have been noted in one or two places.

The work in progress is located in Danbury and Catawba Island Townships, Ottawa County. The Danbury orchard produced a commercial crop in 1925, which showed some significant results. Nitrogen in any form, applied in sufficient quantity, produced better yields than untreated trees. Nitrogen also produced superior trees, which were better able to withstand most pests and untoward conditions than those that were lower in vitality. This point should not be ignored in considering the value of orchard fertilization in general.

There has been no measurable difference, so far, between trees treated with nitrate of soda and those treated with sulphate of ammonia carrying the same amount of actual nitrogen, either in yield, time of maturity, or color of fruit. A longer experience with these materials may alter this observation.

An application of part of the nitrogen in April and the balance in early June (the same total amount as in the above cases) gave no measurable difference in yield, altho there was some suggestion that one application was best. The application of the total amount in the fall instead of spring yielded no beneficial results.

Organic forms of nitrogen, such as in steamed bone meal and digester tankage, gave poorer results than the same amount of nitrogen per tree in the nitrate of soda and sulphate of ammonia plots.

There seemed to be some increase in yield from complete fertilizers over nitrogen alone, altho this is not conclusive at the present time.

There was a delay of a few days in ripening and coloring where nitrogen was applied but it worked to the benefit of the owner this year. There was no increase in brown rot or other troubles as a result of nitrogen treatments.

OHIO SEEDLING APPLES

Each year a number of seedling fruits are sent to the Station for observation and for an opinion as to their value for propagation. In 1912 an effort was made to locate valuable seedling apples that had originated in the State. Cions were obtained from those that seemed to have sufficient quality and were top-worked on Stayman Winesap and a few on King David stock. The fruit trees were planted in 1914.

About 50 of these seedlings have fruited and, altho little accurate information is available concerning their parentage, some indication can be gathered from the appearance of the trees. Many of them apparently belong to the Rome Beauty group, some to the Romanite group, while others have the tree characters of Grimes Golden, Jonathan, Wealthy, Delicious, or some other variety.

As these seedlings come into bearing data are taken on blooming, yield, and keeping quality, and permanent descriptions are made of the fruit.

Some of the outstanding ones to date are Black Rome, Gallia Beauty, No. 61, and No. 73, all of the Rome Beauty type, but more highly colored than that variety. Others of promise are No. 25, a probable cross between Rome Beauty and Grimes Golden; No. 28, an apple of the Sutton type; No. 57, a supposed bud sport of Roxbury and similar to that variety except it is green in color; one of the Rambo type; and one of the Delicious type.

PLUM POLLINATION

The object of this work was to determine the varieties that are self-fertile and self-sterile. Tests of 1924 show that the European plums and damsons, as a group, are self-fertile with a few exceptions. The American, Japanese, and hybrid varieties tested are self-sterile without exception.

CHERRY POLLINATION

This experiment was made to discover the status of self-fertility, self-sterility, and inter-sterility of cherry varieties. Tests of 1924 substantiate the results of the Oregon Station that Lambert, Napoleon, and Bing are inter-sterile in our climate. All sweet cherries tested for self-fertility gave negative results. The sour cherries in this test proved self-fertile and were good pollinizing agents for sweet cherries, when the blooming season took place at the same period.

FALL FERTILIZATION OF FRUIT TREES

The question has been raised recently as to the value or desirability of applying fertilizers to fruit trees in the autumn after growth has ceased, as compared with the usual spring applications. The Station has had some work in progress along this line for the last four years on the apple and for two years on the peach. This is entirely inadequate for conclusions yet a preliminary statement of the results may answer the question of its advisability in Ohio, at least for the immediate future.

From earlier teachings regarding the readily available nitrogenous fertilizers like nitrate of soda and sulphate of ammonia one would expect such a complete leaching that fall applications would be lost. However, the appearance of the fall-treated trees was practically indistinguishable to the eye from that of trees receiving the same amount of nitrogen in the spring. The yield of apples on fall-treated trees was about equal to that of spring-treated trees, and much in excess of that of untreated ones. The peach trees treated in autumn looked nearly as good as those treated in spring; but this year, when an extreme drouth existed thru much of the summer, the spring applications gave markedly better results in size of fruit and total yield.

As yet no points of merit for the practice of fall fertilization, but some practical objections to it, have appeared. However, the work will be continued for a few years to determine with more definiteness its value.

POTATO STORAGE

A potato tuber undergoes gradual physiological changes during the storage period that must be taken into consideration in storage practice. After digging, the tubers are in a resting stage for about three months, and during this period they are easily stored. This resting stage of late varieties ends in January, and the tubers will then sprout if the temperature is above 41° F. At this time, however, it is usually very easy to hold storage cellars or storage houses below 41°, the only difficulty being to keep the potatoes from freezing. With the advent of warm weather in the spring the problem of holding potatoes becomes more difficult, the tendency to sprout increases, and losses of moisture and carbohydrate also increase, with the result that the tubers shrink even in cold storage.

This gradual increase in physiological activity from a resting stage to an active sprouting stage goes on under all storage conditions and in all varieties. No methods have been found for retarding these internal changes. However, as the storage cycle starts at

the time the plant dies or the tubers are dug, potatoes dug in September are in a more active state in the spring than those dug in October. Therefore, tubers from plants that remain green until frost are easier to keep in good condition than tubers from plants that die earlier.

This is the explanation of the fact that Ohio late potatoes keep better in ordinary cellar storage than potatoes from regions of early frost farther north.

CHANGES IN SEED POTATOES DURING THE PLANTING PERIOD

One important factor in the time of planting potatoes is the condition of the seed tubers. The potato undergoes gradual internal changes during the storage period which are reflected in the type of sprouting when planted. A whole tuber in March will generally produce but one sprout, but if held dormant until July and then planted will send out a dozen or more sprouts. With their increase in number the sprouts become weaker. Storage conditions have very little influence on this change in sprouting habit. Potatoes spread out in the light to green, those held in cold storage, and those from which the sprouts have been removed, all undergo the same change.

Cut pieces sprout in much the same manner as whole tubers. In March each piece produces but one sprout, irrespective of the number of eyes or the size of the seed piece. In May most pieces send up more than one sprout, but at this time the size of the piece is a factor, for the larger the piece the larger the number of sprouts. By July there is an excessive sprouting of weak sprouts. A seed piece with just one eye may produce a dozen sprouts from that one eye, for an eye is really a cluster of buds. See Figure 4.

It is obvious that methods of cutting seed and distances of spacing hills should be modified to fit these facts. Each sprout produces an independent plant, so it follows that late plantings have more plants per hill than early plantings from the same seed. Closer spacing of early plantings is therefore to be recommended.

These changes in sprouting habit account for the frequent disappointments when northern grown certified Early Ohios are planted in late July or August for a fall crop. The storage period has been too long and the sprouts are weak.

OHIO CERTIFIED SEED POTATOES

A few potato growers in northern Ohio are attempting to produce certified seed. The inspection of the fields and the certification are handled by the Department of Agriculture, Columbus, Ohio in cooperation with the growers. The Experiment Station for the last three years has tested this Ohio seed in comparison with northern grown certified seed. In these tests the Ohio seed has stood up well in the comparison of yields.

Fig. 4.—Plants from 2-ounce seed pieces of certified Rural Russet potatoes from northern Michigan, planted May 12, June 27, and August 4. The later the date of planting the larger the number of sprouts arising from the seed piece.

A large proportion of the Ohio-grown seed is of distinctly different type from northern strains of the same variety. This is true in both the Russet Rural and the White Rural, the two varieties now being produced. The growers hill-selected types that remained green under Ohio conditions with the result that they have secured strains which are later and more vigorous growing than the strains from Michigan, Wisconsin, and New York. Whether these later maturing types are superior or inferior to the standard northern strains is still an unsettled question. The experiments indicate that they may be planted earlier than the northern strains, and when so planted, give excellent yields. On the other hand, they produce a larger proportion of oversize tubers under our conditions. Interest in these strains is increasing and they are being critically tested by potato growers at several places in the State as well as at the Experiment Station.

CULTIVATION OF GARDEN SOILS

The usual practice of frequently stirring or cultivating the soil in the garden is not as necessary for high production as formerly supposed, if we may judge from the results of an experiment conducted on the silt loam soil of the Horticultural Farm at Wooster.

In this experiment three gardens, or plots, each receiving a different cultural treatment, were planted with tomatoes, Greater Baltimore variety, pruned to a single stem and staked; Stowells Evergreen sweet corn; Succession cabbage; and Henderson Bush Lima beans. All were planted in rows wide enough for horse cultivation. The bush lima beans were harvested when dry and the other crops when they had reached marketable maturity.

One of the gardens was cultivated weekly with a one-horse, 7-tooth cultivator to a depth of 2 to 3 inches. This is the usual practice followed in most gardens and is used as the check treatment in this trial.

In the second garden the weeds were kept down by merely scraping the surface, without forming a dust mulch or stirring and cultivating the soil.

The third garden was covered or mulched with straw to a depth of about 6 inches as soon as the plants were set or the seedlings were large enough to cultivate. This covering was worked closely around and between the plants. Later it settled down to a fairly compact layer 2 to 3 inches in depth that was very effective in preventing the growth of weeds. The few that did grow came up around the plants and were easily pulled by hand. After the growing season the mulch was scattered thinly over all three plots and plowed under with a moderate application of manure.

In two out of three years all four crops were larger on the scraped plot than on the cultivated one. The differences were largest on sweet corn, 22 percent, and cabbage, 15 percent. For the same two years the mulched plot gave a greater yield than the cultivated one by 24 percent for tomatoes, 35 for sweet corn, 22 for cabbage and 10 for dry lima beans. The mulched plot gave the largest total yield for this period, the scraped plot second and the cultivated plot lowest.

The third season, 1924, was unusually wet and cool and the results were opposite to those of the preceding two years. The cultivated plot gave the largest yields, the scraped plot second, and the mulched plot lowest. With an excessive rainfall the soil under the mulch was too wet for proper plant growth, the plants were

yellow in color and smaller than on the other plots. Moisture, nitrate nitrogen, and temperature determinations showed that the mulched plot contained the largest amount of water, least nitrate nitrogen, and was the coolest. The combination of excess moisture and cool soil temperature is very unfavorable for nitrate production, and was the probable cause for the low amount of nitrates present. The nitrates were probably the limiting factor in growth.

This experiment would indicate then that frequent cultivation to this depth in ordinary seasons is not necessary to secure high production, and for some crops is actually harmful. Mulching in addition to increasing the yield saves hand hoeing or cultivation and keeps the fruit much cleaner and freer from rots and disease. In a test with straw mulch at Marietta, however, on a lighter soil where all the straw was plowed under year after year the mulched plot gave unsatisfactory results. The practice of mulching has especial application to home gardens only.

DISTANCE OF PLANTING SWEET CORN

Since in our experiments it has been impossible to greatly increase the yield of sweet corn by the use of fertilizers, an experiment was undertaken at the experimental truck farm near Marietta to determine what increase can be effected by increasing the number of stalks per acre by planting rows and plants closer together. The variety was Adam's Early. In 1924 the largest yield was harvested from plants grown in 30-inch rows with 2 plants every 15 inches. This distance produced 44 percent more than the usual distance which is 3 plants 34 inches apart in rows 36 inches apart. In 1925, 30-inch rows with 2 plants 15 inches apart again gave the largest yield, an increase over the usual distance of 19.5 percent.

DAIRY HERD IMPROVEMENT

The first nine daughters of Choice Owl, the Jersey herd sire, are of better type than their dams and all promise well in production. Daughters of Meadow Holm Jenny King, the Holstein sire, which are now freshening, are of better type than usual and are also promising good production.

Breeding work shows that the improvement of an ordinary dairy herd by the use of untried sires is a slow and uncertain process. A large percentage of young males, tho carefully selected, must fail to transmit high production. An untried male, therefore, may fail to increase the average production of a herd, or even reduce it.

The dam has as much influence on the offspring as the sire, as an average. Therefore, it seems unwise to attempt to build on a foundation of inferior cows. Attention must be given to what the animals transmit as well as to what they are as individuals.

MINERAL BALANCE AS AFFECTED BY PREVIOUS FEEDING AND BY WATER

A metabolism experiment was conducted to determine the effect of well water as compared with distilled water and of the previous feeding upon the mineral balance of milk cows. Four Holstein cows, each giving approximately 32 pounds of milk a day were used in the test. Two of the cows were from the regular herd, which had been pastured the preceding summer, and two were from a herd of dry-feed cows, which had been on an experimental ration for approximately one year preceding this experiment.

All rations during this test were identical, consisting of timothy hay moistened with molasses, beet pulp, and a grain mixture of corn, oats, and bran. Altho the cows received practically three times as much calcium in this ration as was put into the milk, each cows lost calcium.

The losses of calcium sustained by the two cows brought in from the pasture were about double those of the previously dry-feed cows. This difference is explained on the basis that the former two had built up larger reserves while on green pasture grass and under conditions known to be more favorable to calcium storage than the latter, or dry-feed cows, which had always been under conditions known to be conducive to calcium losses. This may be an explanation of the wide variations often noted in calcium balances.

Altho the well water consumed daily by each cow supplied around 2 grains of calcium, the type of water apparently had little effect on the calcium balance. The amount of phosphorus retained by the two cows from pasture was extremely small, that retained by the dry-feed cows was approximately 4 grains a day. The type of water had no apparent effect on phosphorus metabolism.

The metabolism of magnesium was practically the same for both groups, and neither was influenced by the type of water given the cows.

DIGESTIBILITY OF DAIRY RATIONS

Metabolism experiments with dairy cows showed considerably lower digestibility for all the rations studied than the theoretical digestibility calculated from average published coefficients. Rations low in protein seemed to depress digestibility more than

those of higher protein content; altho some rations containing the same proportion of protein varied considerably in this respect. Low digestibility as measured in the metabolism experiment did not always indicate reduced efficiency.

HIGH AND LOW PROTEIN

Experiments in high and low protein feeding of dairy cows have been in progress for fourteen years. The results indicate that many of the prevalent ideas as to the necessary amount of protein in the dairy ration are without foundation in fact. They show quite clearly that much less protein is essential both for maintenance and for production than is prescribed by any of the popular standards. The results of this work are given in Monograph Bulletin 389.

SOYBEAN OILMEAL VS. LINSEED OILMEAL IN DAIRY RATIONS

Two groups of four cows each were used in a feeding test to determine the relative value of soybean oilmeal and linseed oilmeal in the dairy ration. The roughage consisted of corn silage and mixed hay fed to both groups alike. The grain rations consisted of one part each of corn, oats, and soybean oilmeal and of one part each of corn, oats, and linseed oilmeal. The double reversal system of feeding was used in the experiment, that is, the group of cows receiving a given mixture during the first period, was changed to the other mixture during the second period, and so on. The two rations proved practically equal, the results showing a difference of only 2 percent in milk production in favor of the soybean-oilmeal mixture.

SWEET CLOVER ANALYSES

Since sweet clover in the last few years has been much advocated for both pasture and hay for dairy cows, analyses were made to determine its content, particularly of lime and phosphorus, as compared with that of other legume roughages. Samples for analysis representing the various stages of growth of the plant, simulating in a rough way the pasture conditions at various seasons of the year, were furnished by Prof. C. J. Willard of the Ohio State University.

The analyses of sweet clover cut June 18 and 28 and reduced to a moisture basis of dry hay, as tabulated below, include percentages of total ash, nitrogen, calcium, magnesium, and phosphorus. Those for alfalfa and red clover, which are included in the table for comparison, represent the averages of a large number of analyses by the

Station Dairy Department, and by the former Nutrition Department as recorded in Bulletins 295, 308, 330, and 363. The analyses of soybean hay are taken from Bulletin 384.

TABLE 17.—Analyses of Legumes

	Ash	Nitrogen	Calcium	Magnesium	Phosphorus
Sweet clover	8.13	2.77	1.181	0.279	0.284
Alfalfa	6.89	2.34	1.156	.271	.207
Red clover	6.63	1.62	.925	.248	.134
Soybean hay		2.14	1.335	.863	.236

While too much dependence should not be placed on this comparison, owing to the small number of sweet clover and soybean analyses, it shows the general fact that sweet clover hay ranks well with the other leguminous roughages in calcium and phosphorus content.

The analyses of the cuttings at different stages of growth showed that sweet clover as pasture will furnish an abundance of lime and phosphorus.

FEEDS FOR FATTENING CALVES

A ration of alfalfa hay, corn silage, oilmeal, and corn proved excellent and economical for fattening Hereford calves in the beef cattle feeding experiment of 105 days, ended June, 1925. Highland Hereford heifer calves, weighing 408 pounds at the start, were used in this trial.

Calves consuming 9.3 pounds of corn, 2 pounds oilmeal, 2.5 pounds alfalfa hay, and 8.6 pounds corn silage made an average daily gain of 2.77 pounds and were in good market condition at the close of the test. Similar rations, consisting of a full feed of corn, about 2 pounds of oilmeal, and a full allowance of corn silage and legume hay, in several other trials at the Station, proved the most profitable for fattening cattle.

In this trial calves with oilmeal omitted from their ration gained ½ pound less per day than those receiving the full ration. Omitting the oilmeal cheapened the ration somewhat, but without the oilmeal it did not produce quite as desirable and profitable a market product. The heifer calves with corn instead of the oilmeal omitted from their ration made a decidedly less profitable showing. The calves on the ration from which both corn and oilmeal were omitted made good growth without fattening, showing the alfalfa hay and corn silage an excellent ration for stocker purposes, where calves are to be subsequently fattened on pasture. A ration of

alfalfa hay, corn silage, and oilmeal thruout the period with corn added during only the latter part of the period gave results which commend this ration during high prices of corn.

Selling.—Rather surprising differences showed up in the values placed upon these fat heifers by representatives of several markets to which Ohio cattle are shipped. These price differences show the need for studying the demands of the different markets so as to ship whatever kind or grade of cattle one may have to the market where they will sell to best advantage.

IMPROVING THE CORN AND TANKAGE RATION FOR PIGS

The corn and tankage ration sometimes fails to maintain the thrift of young pigs, particularly during the winter months. In a winter trial (1) ground limestone, (2) ground limestone and skimmilk, and (3) ground limestone, linseed and alfalfa meal were fed with corn and tankage to determine the effect of their addition to the more or less standard ration of corn and tankage.

The addition of ground limestone increased the rate of growth ¼ pound daily and resulted in slightly greater gains from a given amount of feed. A little less than ½ gallon of skimmilk per head daily in place of half the tankage produced more rapid growth and saved 30.6 pounds of other feed for every 100 pounds of milk. Pigs receiving linseed meal and alfalfa meal in addition to corn, tankage, and limestone grew more rapidly than those on the same ration without these meals; altho in this particular instance they failed to produce any greater gains from a given amount of feed. It is felt, however, that a leguminous roughage in some form should be fed because of the effect in preventing stiffness or rickets.

Vegetarian pigs.—An interesting group in this experiment received a ration of corn, soybean oilmeal, linseed meal, alfalfa meal, 16-percent acid phosphate, ground limestone, and salt. The pigs of this group gained more rapidly than those of any other lot. Their performance shows the possibility of preparing highly efficient rations made up entirely of feeds of plant origin and inorganic materials.

BONE MEAL VERSUS ACID PHOSPHATE FOR PIGS

Experiments with corn and soybean oilmeal and with corn and soybeans showed minerals to be needed with rations of this character, composed of grains and high protein feeds from plant sources. A mixture of salt and ground limestone brought about some improvement in the ration. One of salt, limestone, and 16 percent

acid phosphate, brought about greater improvement, but not as great as one of salt, limestone, and bone meal. A mixture of salt 1 part, ground limestone 2 parts, and bone meal 2 parts, fed at the rate of 2.5 percent of the total ration gave excellent results in several trials. Two tests with corn and soybean oilmeal and two with corn and soybeans showed this mixture to be superior to one of salt, limestone, and acid phosphate. In one trial with each of the above rations it also gave better results than a mixture of salt, hardwood ashes, and acid phosphate.

Ground rock phosphate, which is frequently recommended and used in mineral mixtures for hogs, proved in this and previous experiments to be detrimental rather than helpful. The pigs getting salt and limestone ate 427 pounds of feed for each 100 pounds of gain, while those getting salt, limestone, and ground rock phosphate ate 451 pounds per 100 pounds of gain.

YEAST FERMENTED FEED

Apparently, by making it more palatable and thereby increasing the consumption, fermenting feed with yeast resulted in the production of more rapid gains. The gains were more expensive, however, when the cost of the yeast was taken into consideration. No definite conclusions concerning the feeding of yeast are warranted until other tests have been conducted.

SOYBEAN OILMEALS FOR PIGS

Soybean oilmeals, made by the different methods of extracting the oil from soybeans, have shown wide variations in their worth for supplementing corn for pigs. Four different types of soybean oilmeal were fed with corn to determine the effect of the process of manufacture on their feeding value. The two trials agreed in indicating that meal made by the expeller process and having a nut-like taste and odor and that made by the hydraulic process in which the pulverized beans are cooked with steam are superior to solvent meal and to expeller meal having a raw, bean-like color, taste, and odor.

COOKED AND HEATED VS. RAW SOYBEANS

In a study of the effect of cooking and of heat treatment on soybeans for growing pigs it was found that the digestibility of the raw and cooked soybeans was approximately the same, 82 percent. Roasting the beans tended to decrease the digestibility 5 to 10 percent. While the digestibility was thus reduced by heat treatment,

the palatability and efficiency for growth of pigs were enhanced, as shown by the several feeding experiments with pigs and also with albino rats.

POSTERIOR PARALYSIS IN PIGS

Figure 5 shows one of the lumbar vertebrae (fourth) crushed; a condition which may have been brought about by a violent muscular strain. The soft bone structure, resulting from feeding a grain ration low in mineral and vitamin content, was unable to withstand any unusual strain and collapsed, bulging into the spinal canal, impinging upon the spinal cord, and thus acting as a nerve block for the rear extremities of the animal. Feeding pigs in dry

Fig. 5.—A Cause of Posterior Paralysis in Pigs

lot grain or mixtures of grain products, such as corn, wheat middlings, soybeans, soybean oilmeal, and linseed meal, with salt, unless these be fortified with sufficient minerals, such as limestone, bone meal, acid phosphate, or wood ashes and supplemented by vitamin carriers such as good alfalfa or other legume hay, will very often result in partial paralysis.

PASTURES FOR PIGS

Sweet clover, soybean, rape, and second-growth red clover were compared as pastures for pigs during the summer of 1924. These pastures ranked in the order named, beginning with the lowest, both with reference to the rate of gain and the concentrates consumed for each 100 pounds of gain. There was practically no difference, however, in the growth or feed consumption of the pigs on rape and those on red clover. The soybean pasture was very palatable and doubtless would have made as good a showing as the rape or red clover, if, like them, it had produced new growth after

once being grazed down or had furnished a larger amount of forage. The sweet clover, seeded early in the spring of the same season, provided plenty of pasture but was not eaten readily by the pigs.

RICKETS AND MINERAL REQUIREMENTS

Ground limestone proved much superior to a purified lime product, such as calcium carbonate, in a practical dry-lot ration of white corn, wheat middlings, linseed meal, and salt. Ground limestone, altho made up very largely of calcium carbonate, contains some impurities that, in so far as the mineral requirements of pigs are concerned, constitute the saving feature of this natural rock. Iron appears to be one of these beneficial ingredients. The above grain ration with pure calcium carbonate was much improved by the addition of iron in the form of ferric oxide or copperas, and also by the addition of potassium iodide and sulphur. The rate of growth of the pigs so fed was increased until it approached that of pigs fed ground limestone alone with the basal grain mixture, which was uniform in all lots.

These results showed that young pigs have a rather decided need for iron, as well as other minerals, which are not always sufficiently supplied in the rations. The experimental rations, composed of grains and grain products, which in themselves are deficient in minerals, permitted the mineral needs of pigs to assert themselves.

Toward the end of these 158-day trials the lack of vitamins in the rations was manifest, even tho the pigs were exposed to sunlight, which is known to have some effect in preventing stiffness or rickets. Some of the pigs on each of the dry-lot grain rations showed certain degrees of stiffness or a staggering gait. Pigs on similar rations on pasture did not become stiff or lame. A dry-lot ration must be unusually good with respect to the mineral part of it to prevent stiffness or rickets, which is due to a low vitamin content of the ration.

The addition of either fish meal or tankage to the deficient grain mixture, fed in the barn, served rather well in this respect. They supplied efficient minerals as well as proteins, tho both fish meal and tankage, as found in our previous work, are low in, or devoid of, some of the essential vitamins. The bones of pigs fed fish meal or tankage were in every case very well calcified and strong. Even tho these splendid protein and mineral feeds were fed in the grain mixture, pigs occasionally became stiff. Leafy pea-green alfalfa meal, a pasture substitute in winter, prevented this in a very satisfactory manner.

STOMACH AND NODULAR WORMS IN LAMBS

Experiments in the prevention and control of stomach worm and nodular worm infection in lambs by methods of management and medicinal treatment were continued in 1924. The results of similar tests in 1922 and 1923 are given in the Forty-second and Forty-third Annual Reports.

Three methods of management were employed in 1924, as shown in Table 18. The group of lambs under each method of management was divided, half to go untreated and half to be treated. Those to receive treatment were further divided, and half were given the copper-sulphate and half the nicotine-sulphate treatment. The treatments were administered once each month for four months, starting after the lambs were weaned, at an average age of 116 days.

TABLE 18.—Systems of Management and Post-Slaughter Examinations*

Lot	From birth to weaning January 31—July 3	Weaning to slaughter July 3—October 22	Treatment and stomach worms per lamb			Treatment and nodules per lamb		
			Not treated	Copper sulphate	Nicotine sulphate	Not treated	Copper sulphate	Nicotine sulphate
1	Kept in barn with ewes	On clean rape continuously during grazing season	20	0	1	0	†	0
2	Kept in permanent infestive pasture after it became available with infested, untreated ewes	Same as Lot 1	1529	6	538	4	4	4
3	Same as Lot 2	Kept on permanent infestive pasture with infested, untreated ewes	3125	308	894	14	21	18

*One lamb from each lot died and one ridgeling lamb was removed from Lot 3
†One nodule in one lamb.

The results show that stomach worm infestation in the lambs on permanent pasture with infested ewes was held in check by administering the copper-sulphate treatment; that keeping the lambs in the barn with the ewes until weaning, then continuously on clean rape forage, as in Lot 1, plus the copper-sulphate treatment was sufficient to prevent stomach worm infestation; that the method of management employed in Lot 1 was effective in preventing nodular disease; that the copper-sulphate treatment was a more

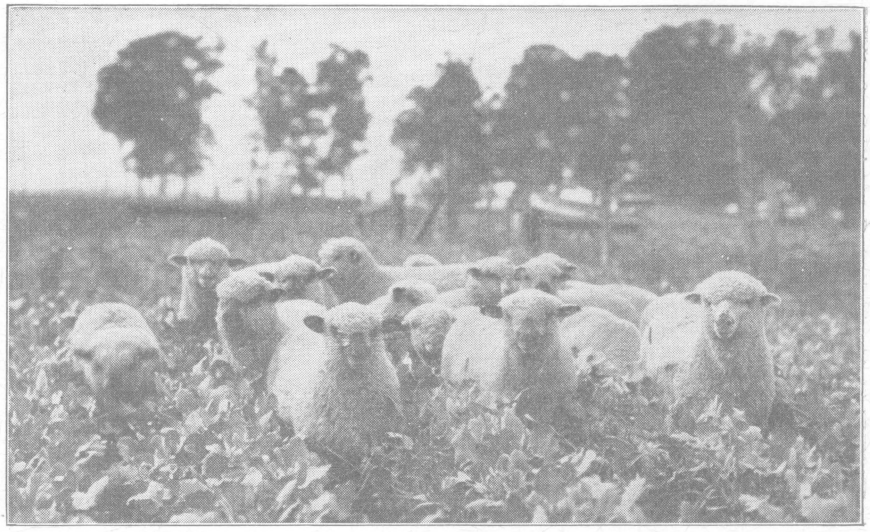


Fig. 6.—Lambs on rape pasture in parasite experiment

Fig. 7.—Nodular disease in sheep

efficient vermifuge than nicotine sulphate; and that the medicinal treatments as employed were of no value in preventing nodular worm infestation.

An experiment in feeding native lambs suspected of being infested with stomach worms showed that it paid to treat the lambs before starting them on feed. When two treatments of either copper sulphate or nicotine sulphate were given to a group of lambs, with a two-week interval between the treatments, the returns per lamb over feed cost were $1.28 to $1.86 greater than the returns per lamb from a similar group allowed to go untreated. The treated lambs made a higher average daily gain than those which were untreated.

DRENCHING LAMBS

In a test conducted to study the course followed by liquid drenches when given to lambs, four lots of 26 lambs each were prepared for drenching as follows:

Lot 1, allowed feed and water.

Lot 2, allowed feed but deprived of water 18 hours.

Lot 3, fasted for 18 hours but allowed water.

Lot 4, allowed neither feed nor water for 18 hours.

Regardless of the preparation of the lambs, in no instance was the drench noted in the fourth stomach when it was not noted in one or more of the three compartments. The different methods of preparation of the lambs prior to drenching did not cause any appreciable difference in the volume contents of the fourth stomach nor in the passage of the drench to it.

BREEDING CULL EWES

In July 1924, 49 ewes were culled from the Station's breeding flock of high grade and purebred Merino ewes. These ewes were culled because of old age, low shearing qualities, undersize, or unsoundnesses which made their ability to raise a market lamb questionable. During years of high lamb and wool prices the temptation to keep such ewes in the breeding flock for another year is great. To determine whether such a practice is of merit these ewes were kept and bred to purebred Shropshire rams for the production of spring lambs. They were sheared and sold with their lambs the following spring. The following financial statement summarizes the results of the experiment:

DEBITS	
49 ewes weighing 4027 lb. valued at $3 per cwt.	$120.81
Ram service for 49 ewes at 25 cents per ewe	12.25
96 days pasture at ¾ cent a day per ewe	35.28
Cost of harvested feed fed to the ewes	326.56
Cost of harvested feed fed to the lambs	40.78
Total debits	535.68
CREDITS	
406.75 lb. wool sold at $0.45 per lb.	$183.04
3550 lb. sheep sold at $2.75 per cwt.	97.63
1350 lb. lamb sold at $17.75 per cwt.	239.63
100 lb. lamb sold at $13.75 per cwt.	13.75
Total credits	534.05

Six ewes died during the experiment. Such debits as taxes, insurances, cost of labor and equipment, and straw used as bedding, and such credits as manure produced, were not included in this calculation. Even tho relatively high prices for spring lambs favored the financial outcome of this experiment, the results showed that it did not pay to retain and breed cull ewes with the intention of selling them with their lambs the following spring.

MEAT MEAL VERSUS MEAT SCRAPS FOR EGG PRODUCTION

High protein meat meals (75 percent protein) recently have appeared on the market in addition to the 50 to 55 percent protein meat scraps (meat-and-bone meal) commonly employed in poultry rations. A preliminary test with 30 Barred Rock pullets to each ration was conducted to determine the relative merits of these products. The grain fed in litter was composed of cracked yellow corn 2 parts, wheat 2 parts, and oats 1 part. The mash consisted of equal parts of ground yellow corn, ground oats, wheat bran, and winter wheat middlings. The mash and grain with green feed, oyster shells, and grit, constituted the basal ration which was fed to all lots alike. To this basal ration was added the meat meal or the meat scraps without and with minerals. The mineral mixture was made up of raw bone meal 60, ground limestone 20, and salt 20 pounds to make 100 pounds. Following are the egg production and percentage of mortality for the 12 months of the test:

TABLE 19.—Egg Production and Mortality

Ration	Eggs per pullet	Mortality percent
Basal plus 20 percent meat scraps (50 percent protein)	150	10
Basal plus 13.3 percent meat meal (75 percent protein)	132	10
Basal plus 13.3 percent meat meal (75 percent protein) plus 2 percent mineral mixture	144	13.2

While a repetition of this test is necessary before conclusions are warranted, these results indicate no advantage of the high protein meat meal over the lower protein product usually employed. The meat scraps, which contain 50 percent protein and 20 to 30 percent mineral matter serve as a double supplement of protein and minerals; whereas, the meat meal, which contains 75 percent protein and but 5 to 10 percent minerals is essentially a protein product and should be considered only as such. It requires additional minerals to supplement properly the grain part of the ration and make it effective. The mortality of the different lots was practically the same.

SOURCES OF LIME FOR EGG SHELLS

Oyster shells and limestone grit are the usual sources of lime for layers in Ohio. Oyster shells are imported, whereas, high grade limestone is a local product. Whether the laying hen can utilize the limestone grit as effectively as oyster shells for egg shell formation is an important question with Ohio poultry keepers. The third year's test on this subject has been completed. The birds were fed grain, mash, and green feed in the usual way. In the first two tests they were confined indoors until June 1, then permitted out of doors; in the third, they were confined indoors during the entire period. The only variable factor between the different lots was the source of lime for egg shells. The shells or grit were fed in separate hoppers accessible at all times. There were 30 Barred Rock pullets to each ration. Each experiment lasted a year.

TABLE 20.—Lime from Different Sources for Egg-shell Formation, Effect on Egg Production and Mortality

Basal ration plus:	Experiment number	Eggs per pullet	Mortality percent
Oyster shells and mica grit	1	134	6.66
	2	145	23.33
	3	150	10.00
Average		143	13.33
Limestone grit (pearl grit)	1	112	20.00
	2	119	23.33
	3	140	16.66
Average		124	20.00
Limestone grit (pearl grit) and oyster shells	1	132	20.00
	2	142	20.00
Mica grit only	1	100	16.66
	2	101	13.13
Limestone grit (crystal grit)	3	140	20.00
Rock phosphate grit	3	126	10.00

The three yearly tests with different groups of pullets in each instance indicated the superiority of oyster shells over the limestone grits employed. While the pearl grit was rather high in magnesium and carried only about 80 percent calcium carbonate, the crystal limestone grit contained little magnesium and about 95 percent calcium carbonate, so the inferiority of the limestone grits as compared to oyster shells does not appear to be altogether determined by the calcium content. The pullets ate the oyster shells more readily than the limestone grits, and this may account for the better results secured from oyster shells. The rock phosphate as employed in the one test was inferior, even to the limestone grits. The failure of mica grit, containing but about 2 percent calcium carbonate, showed the importance of a suitable source of lime for egg shells. These tests indicated oyster shells and limestone grit to be a desirable combination. The need for mica grit in addition may be questioned.

THE ALL-MASH FEEDING OF CHICKS AND GROWING PULLETS

The all-mash method of feeding has been employed for the chicks on experimental feeding tests at the Ohio Station since 1922, and this method was used for all the chicks and the 1800 pullets raised by the Station in 1925. The results were highly satisfactory. This method largely ignores the traditional theory that chicks or pullets must scratch for grain in order to secure best results. An all-mash method of feeding chicks was announced by the Wisconsin Station in 1924.

The simplicity of the method, as compared to the customary procedure of feeding both grain and mash mixtures, each in turn being changed or manipulated at various times according to the age of the chicks, is evident. A simple economical mash mixture made up of the following parts proved effective:

The mash mixture	Pounds per hundred
Ground yellow corn	70
Winter wheat middlings	20
Meat scraps (50 percent protein)	5
Raw bone meal (chick size)	4
Salt	1
Oyster shells in separate hoppers	
Skimmilk or buttermilk to drink instead of water during the first 10 or 12 weeks.	

The milk was discontinued, except for late hatches, when the pullets were transferred to the summer range. No change was made in the mash or method of feeding it until the pullets were removed from the range to winter quarters in the fall.

Some of the advantages of the all-mash method of feeding chicks or pullets are: The feeding problem is simplified; less labor and skill in feeding are involved; and it is more sanitary than feeding scratch grain in litter or on soil that is often filthy or contaminated with disease. Further details pertaining to this method will be furnished by the Station upon request.

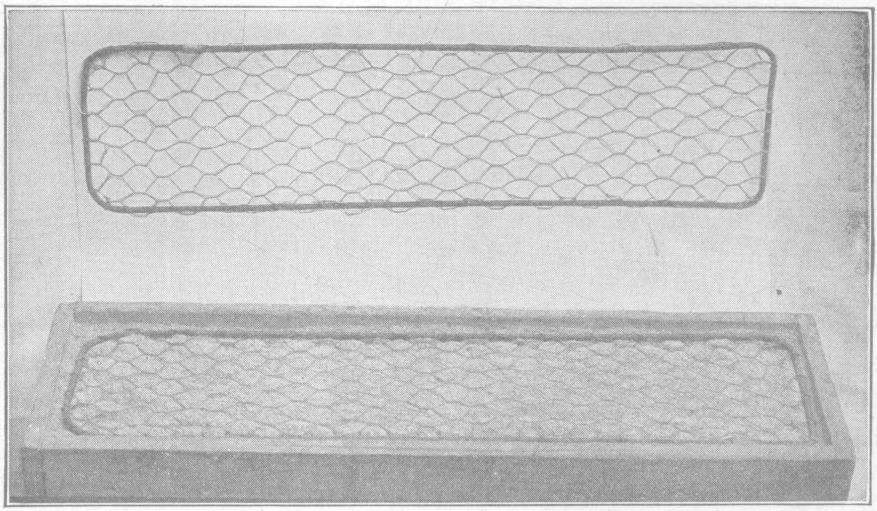


Fig. 8.—Mash box and grid to prevent waste. A sample grid shown above. The mash is readily available for the chicks and prevents waste from scratching

GROUND GRAIN VERSUS WHOLE GRAIN FOR EGG PRODUCTION

What proportion of grain and mash to feed the layers is a complex problem. Good results have been secured from a large proportion of grain and vice versa. The grains are inadequate so far as proteins and minerals are concerned; therefore the ration is often unbalanced in this respect because of the feeding of a large proportion of scratch grain. The proteins and minerals are usually provided in the mash or by supplying skimmilk or buttermilk liberally. From the sanitary point of view, the feeding of scratch grain in the litter is a questionable practice. Unless the litter be removed every two weeks from the average house affording 3 or 4 square feet of floor space per bird, it becomes contaminated and is an unfit place to feed the grain.

While the merits of the all-mash method of feeding the layers are not so well established as for the chicks and growing pullets, the

results thus far secured appear promising. During the year of 1924-25, 700 pullets and hens were fed in various experiments to secure information along this line. In no case did the method prove disadvantageous. Some of the results are as follows:

TABLE 21.—Ground Grain versus Whole Grain for White Leghorns With Outside Range

Method of feeding	Number and kind of birds	Eggs per bird	Mortality, percent
Grain[1] and mash[2]	50 pullets at Southeastern Test Farm	153	12
All-mash[3]	50 pullets at Southeastern Test Farm	150	14
All-mash[3]	50 pullets at Wooster	159	8
Grain[1] and mash[2]	104 hens at Northeastern Test Farm	122	8.7
All-mash[3]	104 hens at Northeastern Test Farm	119	4 8

The feed mixtures in this experiment were:

1. Grain: Cracked corn 2, wheat 2, oats 1
2. Mash: Ground corn, ground oats, wheat bran, winter wheat middlings, and meat scraps (equal parts)
3. All-mash: Ground corn 30, ground oats 20, wheat bran 10, winter wheat middlings 10, meat scraps 10

The experiment began October 30, 1924 and continued 11 months.

The results indicated no advantage of feeding grain in the scratching litter and a dry mash in the usual way over same feeds used only in the form of a mash.

If the all-mash feeding of layers proves well adapted for general use by poultry keepers, it will have some important advantages over present methods. As in the case of chicks and pullets, it lessens labor, simplifies a number of feeding problems, involves less skill in feeding, and is more sanitary.

SUPPLEMENTS THAT IMPROVE THE RATION FOR LAYERS

There appear to be a number of rations equally effective for chickens; but all grains, their by-products, and packing-house by-products are alike in that certain supplements are required to make them most effective or to complete the ration. Such a complete ration is composed of five parts:

1. Grains and their by-products
2. A protein concentrate
3. Minerals
4. Vitamins
5. Anti-rachitic factor

An incomplete ration generally lacks one or more of the last three of these parts. Since certain supplements are such a determining factor in the value of most rations, a study of some of the more promising ones was made during the past year.

In these tests a ration extensively used by poultry keepers was employed without any supplement and with different supplements. This "control" ration consisted of *grain* (yellow corn 2, wheat 2, oats 1) and *mash* (ground yellow corn, ground oats, wheat bran, winter wheat middlings, and meat scraps, equal parts). The all-mash method of feeding was employed; so the grain was ground and fed as a part of the dry mash, equal parts by weight of grain and mash. No scratch grain was fed. The composition of the mash (combined grain and mash) as fed was ground yellow corn 30, ground wheat 20, ground oats 20, wheat bran 10, winter wheat middlings 10, meat scraps 10. Oyster shells and grit were available at all times.

To this "control ration", the various supplements were added with results as follows:

TABLE 22.—Effect of Supplements on Egg Production and Mortality

Ration	Eggs per bird	Mortality, percent
Experiment 1 at Wooster		
Control ration only	95	44
Control ration plus skimmilk to drink (no water)	134	32
Control ration plus alfalfa hay, chopped	125	12
Control ration plus cod-liver oil, 2 percent	141	10
Control ration plus bluegrass range	159	8
Experiment 2 Southeast Test Farm		
Control ration only	89	40
Control ration plus cod-liver oil, 2 percent	124	6
Control ration plus bluegrass range	150	14

There were 50 White Leghorn pullets to each ration. The experiment continued 11 months, Oct. 30 to Sept. 30. All pullets, except those on bluegrass range, were confined indoors where direct sunlight was mostly excluded.

The failure of the control ration to meet the requirements of laying pullets confined indoors with little direct sunlight was evident. The failure appears to be due to lack of vitamin A and the anti-rachitic factor (direct sunlight) since marked improvement resulted when the supplements carrying these factors were employed. The alfalfa hay proved surprisingly beneficial. While the skimmilk increased egg production, it failed to prevent heavy mortality. This was according to expectations, for skimmilk is a poor source of vitamin A, or the anti-rachitic factor. The cod-liver

oil was effective in preventing mortality and increasing egg production. It was also observed that the pullets receiving the cod-liver oil produced eggs with much stronger shells than the other groups confined indoors. Of all the supplements, however, the bluegrass range with direct sunlight was superior.

Nutritional roup was responsible for a large part of the mortality from the groups receiving the control ration, and the control ration plus the skimmilk.

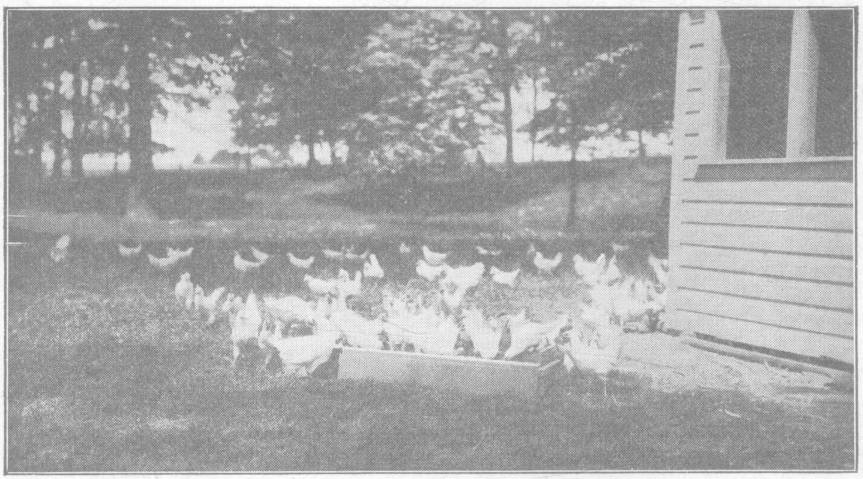


Fig. 9.—The All-mash feeding of pullets on summer range

Nine different tests of hatchability of the eggs were made during the hatching season. The eggs from the pullets on bluegrass range hatched better than any of the indoor groups. No improvement in hatchability resulted from the cod-liver oil. It appears that direct sunlight or ultra-violet irradiation is essential for best hatchability of eggs.

STABILITY OF COD-LIVER OIL IN FEED MIXTURES

To test the stability of cod-liver oil in a feed mixture, four lots each containing 20 day-old White Leghorn chicks were fed a basal ration impregnated with 2 parts of cod-liver oil per 100, the cod-liver oil fresh or having been stored with the feed in various ways. The basal ration was made up of grain (ground white corn 2 and wheat middlings 1) 80 parts, casein 16 parts, and minerals (bone ash 3, calcium carbonate 1, and sodium chloride 1) 4 parts. For Lot 1 fresh cod-liver oil, prepared in 2-week quantities was added to the basal ration which had been stored at 70 degrees F. for 4

months prior to starting the feeding test. For the other lots the cod-liver oil was mixed with the basal ration at the beginning of the 4-month storage period. The mixture for Lot 2 was kept in gunny sacks at 32 degrees; for Lot 3, in gunny sacks at 70 degrees; for Lot 4 in 2-inch layers at 70 degrees.

In general the results for livability, growth, etc., showed fresh cod-liver oil, Lot 1, best. The oil-mixed feed stored in gunny sacks at 32 degrees, Lot 2; and 70 degrees, Lot 3; followed in order. The oil-mixed feed stored in layers at 70 degrees, Lot 3, was decidedly poorest, only 3 chicks surviving at the 12th week.

No signs of leg weakness were evident in any of the lots. A ruffled condition of the feathers indicated a nutritional failure of rations in Lots 3 and 4. An analysis of the tibial bone from representative chicks of the several lots at 12 weeks indicated no apparent difference in ash content. This indicates that the anti-rachitic vitamin was not greatly attenuated during the 4 months storage; and the vitamin A was wholly or partly destroyed, depending upon the condition of storage.

CALCIUM REQUIREMENT OF THE GROWING CHICK

Chick feeding tests at the Station have shown a ration of white corn, wheat middlings, casein, salt, and cod-liver oil to be deficient in the mineral elements, particularly calcium. In order to determine how much calcium must be added to a ration of known vitamin content to insure normal well-being, eight groups, each of 15 day-old White Leghorn chicks, were fed the same basal ration, but supplemented with a different amount of calcium carbonate for each group. The basal mixture was white corn 55 parts, wheat middlings 24, casein 16, salt mixture 3, and cod-liver oil 2. This was supplemented with 0, 0.125, 0.25, 0.5, 1, 1.5, 2, and 4 parts of pure calcium carbonate per 100 pounds of the mixture for the respective groups.

The results indicated that approximately 1.5 pounds of calcium carbonate had to be incorporated in 100 pounds of the basal mixture to insure against leg weakness and to produce a maximum ash content of bone.

Leg weakness.—A feeding test was conducted to determine the efficiency of various calcium salts and supplements in the prevention of leg weakness in chicks. Eleven groups of 15 day-old White Leghorn chicks each were housed indoors in 3 by 6 foot pens with floors covered with pine shavings. All groups alike received distilled water to drink and were fed a dry mash of yellow corn 62,

wheat middlings 25, casein 10, salt 1, and cod-liver oil 2 parts. To this basal ration an amount of calcium equivalent to 1.5 percent of calcium carbonate was added, the calcium carrying substance being different for each group. The materials used were calcium carbonate, calcium sulphate, calcium lactate, tri-calcium phosphate, di-calcium phosphate, raw-rock phosphate, raw-bone meal, spent bone black, ground limestone, bone ash, and precipitate bone flour.

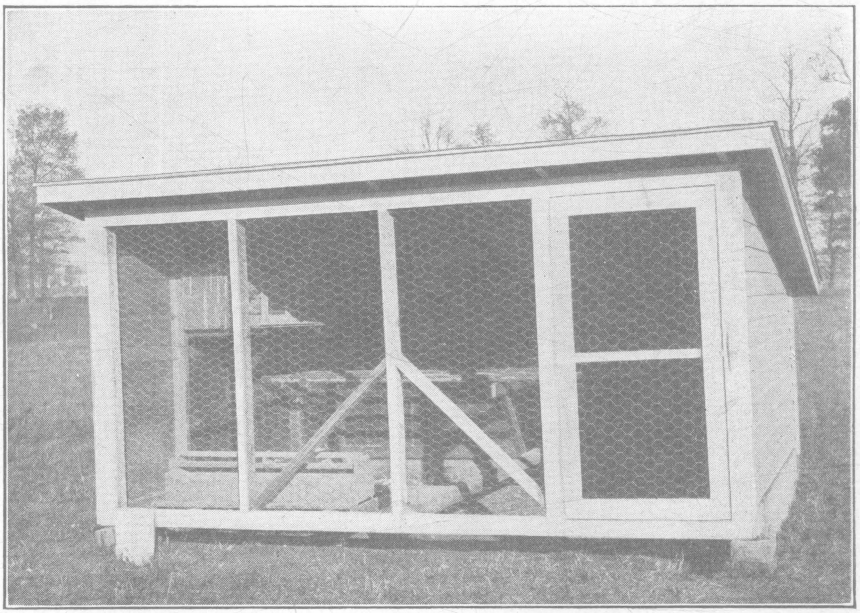


Fig. 10.—Portable colony house for the summer range. This house is 10 by 12 feet; with front entirely open and with neither floor nor windows; its cost is much less than that of a brooder house

The chicks were kept on their respective rations for 12 weeks, when representative birds from each group were killed for bone analysis. In general the results indicated that all supplements except raw rock phosphate were equally efficient in preventing leg weakness and in producing a bone of normal ash content. The best growth was obtained where either tri-or di-calcium phosphate, raw bone meal, spent bone black, or bone ash was added.

COCCIDIOSIS IN CHICKS

The control of Avian Coccidiosis was undertaken by placing affected chicks upon a floor of one-inch poultry netting so elevated as to permit droppings to pass beyond the reach of the chicks. In

one pen healthy and infected chicks were associated upon a netting floor while in another a similar group of chicks were on a cement floor covered with wood shavings. The death rate of infected chicks on the netting floor was 36 percent, on cement 67 percent; of healthy exposed chicks on netting floor 0, on cement 42 percent.

These preliminary experiments indicate that benefit is to be derived from a method of management which prevents access to the droppings or anything contaminated by them.

FORESTRY LEGISLATION

Forest Taxation.—The 86th General Assembly by enactment of the Bolton Bill (Amended Senate Bill 186) provided for the classification of forest lands for purposes of taxation. The act defines forest lands, with the provision that when so classified according to law the local rate of taxation on the assessed valuation of the land may be reduced 50 percent. The value of any timber whether young or mature cannot be considered in assessing valuation of the land, but all other improvements and values other than agricultural, such as mineral, shall be valued as prescribed by law.

The Act provides that lands which have been classified as forest lands and listed on the tax duplicate as such may be withdrawn from such class by application to the county auditor of the county in which the lands are located. The owner will be required to pay the difference in the amount of the tax which would have been due at the rates established for the years for which recovery is sought together with legal interest, had the lands been taxed at the full rate. Lands classified for a period of 25 years or more before withdrawal are not subject to collection of back taxes. Provision is made in the Act for an excise or products tax on timber cut or removed from classified lands. This is designed to take the place of an annual tax on the timber. The rate of the excise tax is 5 percent of the value of the timber on the stump when it is cut, exempting such timber used on the lands of the owner for domestic purposes or for domestic improvements having a taxable value.

All forest lands under classification must be maintained in productive condition, and protected as far as possible against devastating agencies such as fire and grazing. Desultory cutting is not permitted.

The Act is administered by the state forester, but all rules and regulations relative to classification must be approved by the State Tax commission. Both agencies are given wide latitude in the administration of the Act.

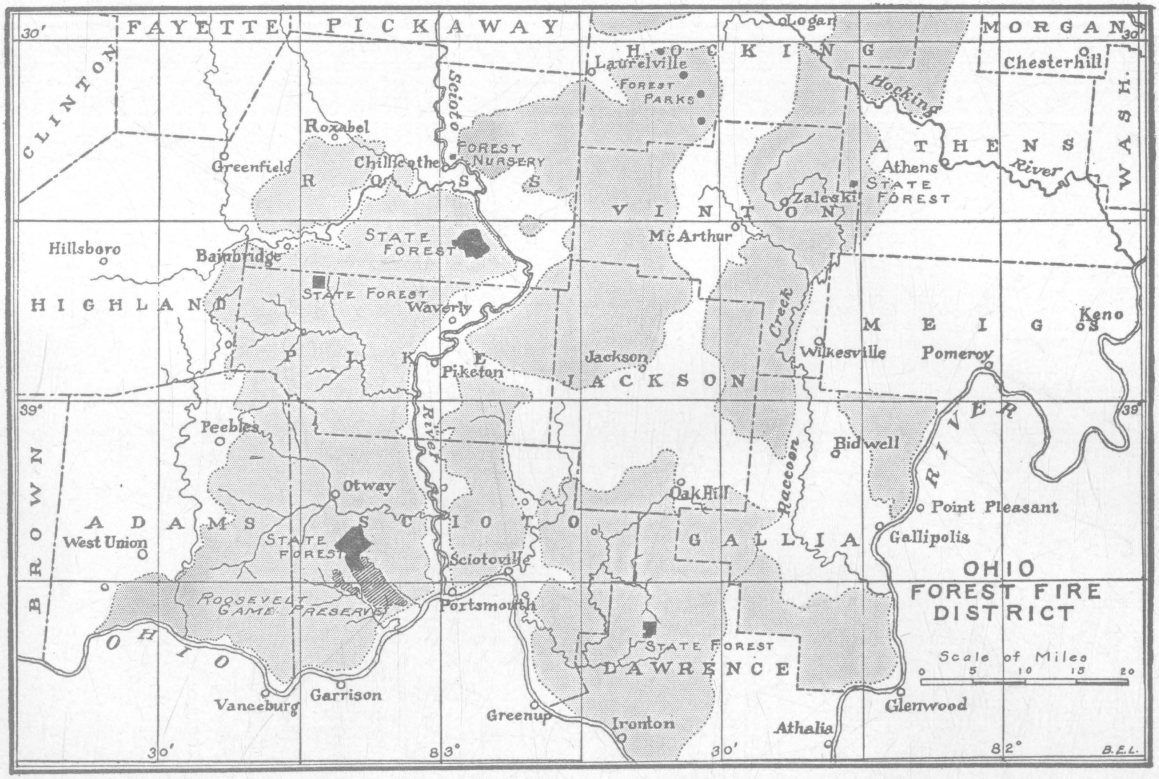


Fig. 11.—Map of Ohio Forest Fire District showing forested area in need of protection, and the location of the State Forests, Forest Parks, and Roosevelt Game Preserve

The purpose of the classification act is to offer encouragement to the landowner to grow better forests and utilize idle and low grade agricultural lands for forestry. While an owner can benefit directly by reduced taxes in classifying his forest lands, he will automatically benefit by increased timber yields, because he is required to keep the forest in a state of continuous production, under advice and counsel of the Forestry Department.

There is a growing tendency to assess timber for taxation separate from the land. If the general property tax were strictly enforced against standing timber, it would consume the value of the timber, and would soon be confiscatory in operation.

Under the Bolton Act the excise tax on timber cut and removed from the woods is nominal and is of course deferred until the crop is harvested. Under the general property tax an owner may pay an annual tax on timber over a period of years, and then have it destroyed by fire, insects, or disease before he can harvest or realize on it.

Forest nursery.—The General Assembly appropriated $15,000 for the purchase and development of a new forest nursery site. A tract of 56 acres located near Marietta in Washington County has been purchased, and will be in operation in the spring of 1926.

FOREST PLANTING

Interest in forest planting continues to increase among all classes of landowners. During the year 402,264 trees, consisting of 23 species were distributed to 216 owners. These plantations will become the basis for the development of forest planting policies for the different soil types of the State, which exist in great variety. The soils of the east half of Ohio, typified by sandstone and shale derivation, present quite different problems from that of the west half, largely of limestone formation. Within these two groups are soils and formations in considerable variety. The planting of trees to date indicates that careful study must be given to the adaptation of species for the numerous soil formations. Whether exotic or native trees can be used to best advantage from the aspects of adaptation and timber use, is a matter to be determined largely by the employment of as wide a range of species as possible under the different conditions.

Studies of the earlier plantations of pine and hardwood species on lands under continuous agricultural cropping in the unglaciated sections of southern Ohio indicate quite clearly that hardwoods of

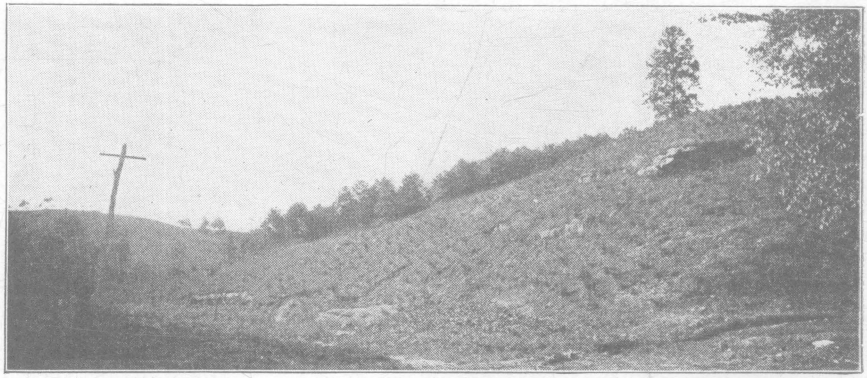


Fig. 12.—Abandoned field of Waterloo State Forest in 1917, photograph just after planting to white pine

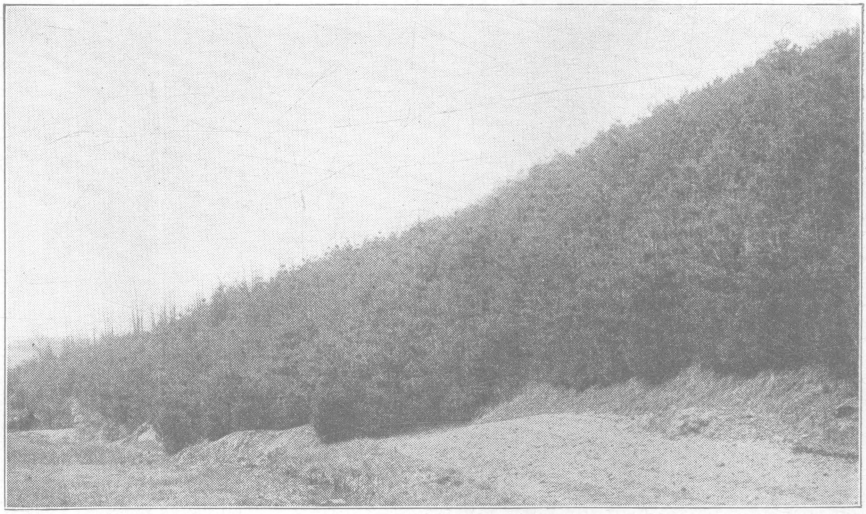


Fig. 13.—The same tract six years after planting to white pine. Trees 12.5 feet in height

the most desirable species for timber production cannot compete with several species of pines in growth on old fields where soil depletion and erosion has occurred to any appreciable extent.

The following data show comparative growth of the red oak and white pine on similar sites at Waterloo State Forest in Athens County. Both sites were hillside fields of southeasterly exposure and had been under cultivation for a great many years.

TABLE 23.—Comparative Growth of Forest Plantations

	Year planted	Age of planting stock	Size of planting stock, inches	Average height of trees, feet	Average diameter of trees 4½ feet above ground, inches
Red oak.....	1918	1-year seedlings	10—12	3.3	
White pine ..	1917	4-year transplants	10—14	12.4	1 9
Red pine.....	1917	4-year transplants	8—12	12.7	2.2
Scotch pine.	1917	4-year transplants	10—14	15.0	2.1

In the red oak planting only about 35 percent of the trees had survived at the time growth data were taken, as against 99 percent of survival for the white, red, and Scotch pine stands.

It is quite evident that pine is better adapted to representative old field sites than red oak. Other plantations offer additional evidence to this effect, and also in respect to other hardwood species, such as tulip poplar and ash, exception being made of black locust, and even this prolific grower does not promise yields comparable to pine on the most adverse planting sites.

FOREST NURSERIES

Nurseries.—Four nurseries are being operated by the Station for the production of forest planting stock. This stock is used on the public forests, and on the lands of private owners for the reforesting of idle and low grade areas.

TABLE 24.—Inventory of Tree Seedlings and Transplants in the Forest Nurseries

Nursery	Hardwoods		Conifers—pine, spruce, fir, larch, etc.		Total
	Seedlings	Transplants	Seedlings	Transplants	
Wooster.....	1,000	.....	2,716,714	12,000	2,729,714
Chillicothe..... ...	728,412	34,000	1,153,100	88,268	2,003,780
Rock House..... ...	.....	.....	1,500,000	24,800	1,524,800
Shawnee State Forest	.....	.....	300,000	.....	300,000
Total.....	729,412	34,000	5,669,814	125,068	6,558,294

The nurseries are an essential feature of the forestry program, since it is impossible to obtain planting stock of the species and size, nor can any stock be obtained at a cost that the landowner can afford to pay for such material. Forest seedlings are furnished free of cost to private landowners, but must be planted under instructions from the Forester.

PUBLIC FORESTS

Working plans.—Field work has been completed on a management plan for the Shawnee State Forest in Scioto County. This includes a detailed topographical map, determination and distribution of timber stands, age classes, growth, and yield studies. This tract contains a considerable scattering stand of original timber trees, which were left as culls at the time of the last logging in 1900. These trees now promise to yield some revenue from their products.

Forest planting.—Experimental plantations of 33,675 trees, consisting of 11 species were established on the abandoned field soil types on the Scioto Trail, Shawnee, Waterloo, and Dean State Forests, and on Rock House, and The Gulf Forest Parks. Most of the forest parks contain abandoned fields, and open land which offer unusual opportunities for experimental forest plantations.

Acquisition of public forests.—During the fiscal year no new purchase units were established for state forest purposes. Land purchases were made which provided for the enlargement of Scioto Trail, Ross County, by the addition of 1400 acres; Pike, Pike County, 993 acres; Dean, Lawrence County, 195.59 acres. A total of 2588.59 acres.

Two new forest park units were added during the year: Rock House Hocking County, of 171 acres, and Konkles Hollow, Hocking County, of 232.18 acres. These tracts contain some of the finest sandstone gorge scenery in Ohio, as well as a wealth of virgin timber and unusual flora.

The total forest land acquisitions for the year were 2,991.77 acres. The average cost of state forest lands to date is $6.11 per acre, and for forest parks approximately $48 per acre. Some of the parks contain timber in quantity and quality to cover the original purchase price. The cost of Rock House was $10,000. It is estimated to contain $11,100 worth of timber.

FOREST FIRES

The menace of forest fires on 1,150,000 acres of southern Ohio timber lands continues to be a pressing forest problem. The extent of devastation resulting from fires in the Ohio River counties has

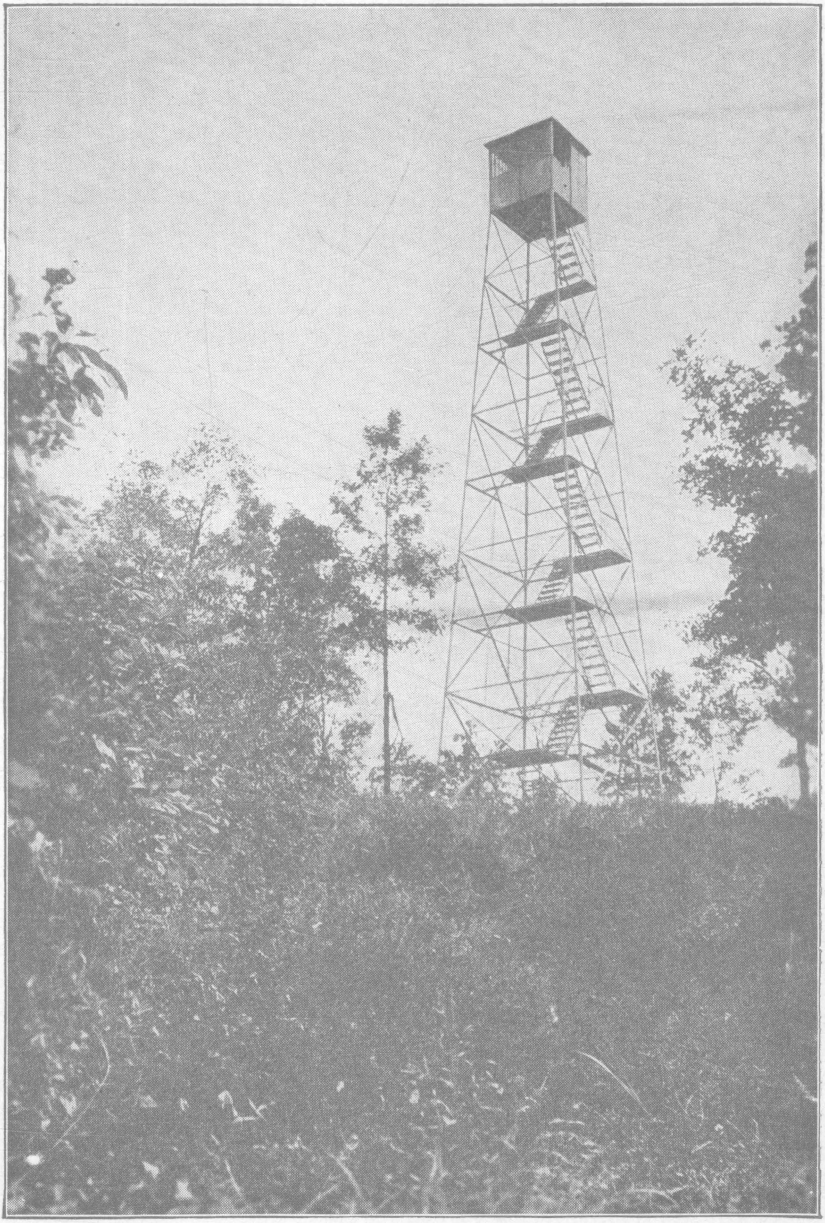


Fig. 14.—Copperhead Hill Lookout Tower, Shawnee State Forest, Scioto County, Ohio

not been fully appreciated by the people of the State because it has occurred in the restricted fire district, and largely away from the centers of population.

Of the 1,150,000 acres in the fire district, some 750,000 acres is quite adequately protected under the forest fire organization. More wardens are needed in certain portions of the organized district. Weaknesses in the detection and suppression of fires develop where wardens must cover too large districts, and can be corrected only by the appointment of additional deputy wardens.

TABLE 25.—Summary of Forest Fires by Causes

Cause	Fall 1924		Spring 1925		Totals		Damage	Cost to extinguish
	No.	Area	No.	Area	No.	Area		
Lightning	1	0.25	0	.....	1	0.25	.....	.....
Railroads	19	700	16	407.5	35	1,107.5	.....	.....
Brush burning	2	30	39	4,971	41	5,001.0	.....	.....
Campers and hunters	10	1,378.5	18	1,073.5	28	2,452.0	.....	.....
Incendiary	7	123	17	2,489.5	24	2,612.5	.....	.....
Miscellaneous	7	627.25	7	737	14	1,364.5	.....	.....
Unknown	22	8,114	40	6,043	62	14,157.0	.....	.....
Total	68	10,973	137	15,721.5	205	26,694.75	$80,430	$3,039.29

The prevention of forest fires is largely a matter of education. With the growth of forestry interest, and the proper attitude toward growing forests, will also develop a greater interest and responsibility on the part of individuals in being careful with fires where there is danger of burning the woods. In Ohio practically every forest fire can be traced to carelessness or intent. Where people really become forest minded the fire menace will be greatly decreased. Until such time forest fire laws and organizations under state control will be necessary to keep the annual burned area to the lowest possible minimum. The laws against incendiarism or carelessness, and the organized warden service can not in themselves prevent all fires, any more than the fire departments can prevent fires in cities. But the laws and organization can and do prevent many fires that would otherwise occur, and they greatly reduce the area burned and the damage which might result from individual fires. As the fire organization extends its scope, and learns by experience how to prevent and suppress fires, it will become more efficient.

The Bimonthly Bulletin of Sept.-Oct., 1925 contains an article describing in detail the causes and effects of forest fires.

The forest wardens and deputies now in service in Ohio number 300. They are residents of the districts in which they have authority. They receive no pay other than that for the time employed.

THE CHRISTMAS TREE INDUSTRY

Some interest has developed among landowners in growing evergreen trees to supply the Christmas trade. During the last five years approximately 1,000,000 seedlings have been purchased and planted for the purpose. The species used are largely Norway and white spruce. Records on the earlier plantations indicate that the business is profitable, altho one that has possibilities of being over done in the future.

The bulk of the supply of Christmas trees imported into Ohio has come from New England and Canada. These trees are cut in October, and November. By Christmas they have lost their freshness, and the needles commence to fall a day or two after the trees are taken into a warm room. In shipping, the trees are handled tightly, and the branches are broken and bruised by the thongs with which they are tied.

The home-grown trees are free from these objections. They can be cut a few days before Christmas and placed on the market, the foliage remaining in good condition much longer.

It has been amply demonstrated that Ohio landowners can readily supply the demand for Christmas trees in the State, and can furnish a much better quality of trees than can be imported from the north woods. Norway and white spruce will grow to Christmas tree size in almost every section of Ohio, excepting on soils that are wet and swampy. Steep hillsides and generally low grade lands can be used for the purpose. Four-year-old transplants of spruce are best for starting plantations, and from 2,750 to 3,500 trees can be planted to the acre. Harvesting can commence the fifth year, and the rotation should be complete in ten years.

In 1919 a Christmas tree planting of approximately ¼ acre was made at the Experiment Station. The ground was in heavy sod and was plowed and prepared as for farm crops. The trees used were 4-year-old transplants from 12 to 16 inches high. The following table gives costs and profits to December 25, 1925.

Costs Per Acre for Formation and Marketing and Profits from Christmas Tree Plantings

COST

Preparation of site, plowing and harrowing	$ 10.00
Cost of trees, 4 yr. transplants (2,720)	40.55
Planting trees	8.10
Cultivating 2 seasons	21.60
Mowing weeds 3 seasons	12.00
Total cost of formation	$ 92.25
Cutting and delivery of 1,368 trees	98.34
Total cost	$190.59

RETURN

Fourth year after planting	1923 cut	104 trees	3½-6 ft. high	$ 104.00
Fifth year after planting	1924 cut	172 trees	3 -7 ft. high	206.00
Sixth year after planting	1925 cut	1,092 trees	3 -8 ft. high	948.12
Total		1,368 trees		$1,258.12
Net profits exclusive of interest charges and taxes				1,067.53

Approximately 1,300 trees still remain in the plantation which can all be harvested in the winter of 1926. They could have been marketed for Christmas, 1925 but were permitted to stand for larger specimens.

Many planting sites cannot be plowed, such as steep hillsides or stony ground. It is not necessary as the trees can be planted without such preparation. In such cases planting costs are about doubled, and cutting of sizable trees must be deferred on the average of two years longer. Cultivation for the first two years stimulates growth and gives the trees a start, but as a rule it should cease at the end of the second season.

The cost of 4-year transplants will vary. If 2-year seedlings are purchased at about $8 per thousand, and lined out in nursery rows for two years, the total cost of the 4-year transplants should not exceed $15 per thousand.

Costs of establishing larger acreages of Christmas tree plantings can undoubtedly be made cheaper than those given for the Station plantation. However, to sacrifice initial preparation of soil and subsequent cultivation and weeding if needed, will extend the period of rotation and the time that the first trees become marketable.

The trees from the Station plantation were marketed about equally to the retail and wholesale trade. Had the average price per tree been 50c wholesale, the net profit per acre for 6 years exclusive of interest charges and taxes would have been at the rate of $82 annually. Even at the rate of 25c per tree, an acre of Christmas trees would mean good profits on much land now practically idle, *providing the stock can be marketed at Christmas time.* What prices

and marketing opportunities will be in the future is of course speculation. That more trees will be used in the future than in the past is almost certain, for the home-grown tree is its best advertisement and salesman.

DISTRICT AND COUNTY EXPERIMENT FARMS

In addition to the central Station farms at Wooster, the State maintains three district test farms, located at Strongsville, near Cleveland; Germantown, near Dayton; and Carpenter, near Athens. There are also nine county experiment farms owned by the county in which situated, but under the supervision of the Ohio Experiment Station.

Variety tests.—On these twelve farms, as well as at the Station, are to be found variety tests of grains conducted over a period of years. These tests include the more promising varieties developed at Wooster and show how widely they are adapted in Ohio. The value of such extensive tests is demonstrated in the rapid spread of Trumbull and Fulhio wheats, originated at the Station and introduced after extended trials, now probably comprising one-half of Ohio's wheat acreage. The willingness of Station and College agronomists to encourage the adoption of these varieties was founded on their splendid showing in comparison with other varieties at so many widely separated points.

Fertility tests.—Likewise there are long-time tests of fertility treatments on the twelve farms. These were plannnd to supplement those at Wooster and give information in regard to the response of other soil types to the various plant foods. These tests show considerable differences in regard to nitrogen, potassium, and lime treatments. They show a general response to phosphorus, altho this is more striking on some soil types than others. The value of such tests to Ohio farmers as well as to station and college workers can be readily seen in the following table which shows how widely Ohio's soil types are represented.

SOIL TYPES ON OHIO EXPERIMENT FARMS

	LOCATION OF FARM	SOIL TYPES ON FARM	OTHER TYPES IN SURROUNDING AREA
1.	Wooster	Wooster silt loam Canfield silt loam	Volusia silt loam
2.	Strongsville	Mahoning silty clay loam Trumbull silty clay loam	
3.	Carpenter	Dekalb silt loam Meigs silty clay loam	Upshur clay
4.	Germantown	Miami silt loam	Bellefontaine silt loam Brookston silty clay loam
5.	Belmont Co.	Dekalb silt loam	Westmoreland silt loam Belmont silt loam
6.	Clermont Co.	Rossmoyne silt loam Clermont silt loam	Cincinnati silt loam
7.	Hamilton Co.	Miami silt loam Brookston silty clay loam	Cincinnati silt loam
8.	Madison Co.	Miami silty clay loam Brookston silty clay loam	Clyde silty clay loam
9.	Mahoning Co.	Canfield silt loam Volusia silt loam	Ellsworth silt loam Mahoning silt loam
10.	Miami Co.	Crosby silt loam Brookston silty clay loam	Miami silt loam Brookston silty clay
11.	Paulding Co.	Paulding (Brookston) clay	Paulding clay
12.	Trumbull Co.	Mahoning silty clay loam Trumbull silty clay loam	Volusia loam Volusia clay loam
13.	Wash. Co. Exp. Farm	Meigs silty clay loam	Upshur clay Dekalb silt loam
	Wash. Co. Truck Farm	Chenango silt loam Chenango very fine sandy loam	Chenango loam Chenango gravelly loam

At the Northeastern Test Farm, the Station Poultry Department has conducted feeding tests with White Leghorn hens. A test which started on October 23, 1924 and ran for 11 months compared the all-mash method of feeding with the grain and mash method. Standard feeds, the same for both lots, were used, the only difference being in the manner of preparation. One lot had all of the feed ground into a mash, the other received part in the form of unground grain. The hens receiving all mash were given a warm moist mash at 4 p. m. daily from January 1 to May 7. Cabbage, oyster shells, and grit were furnished alike to both lots.

All-mash lot, 104 hens averaged 119 eggs, mortality 5, mash and grain lot, 104 hens averaged 122 eggs, mortality 9.

The Southeastern Test Farm, located in the hill section of Ohio, is a logical place for sheep investigational work. An interesting test of the year was comparison of equal weights of ground soybeans, whole soybeans, and linseed oilmeal as supplements to a liberal ration of shelled corn, alfalfa hay, and corn silage in the fattening of native light B- and C- type Merino ewe and wether lambs. The linseed oilmeal and ground whole soybeans were each fed in the

proportion of 1 part to 7 parts corn. The three lots made practically the same gains over the feeding period of 126 days. Based on values of $60 per ton for whole soybeans, $62 for ground soybeans, and $55 for linseed oilmeal with corn at 70 cents per bushel, alfalfa $15 per ton, and corn silage $5 per ton, the costs per 100 pounds of gain were $11.79, $11.37, and $11.36, respectively, for the linseed oilmeal, whole soybeans, and ground soybean groups. One lamb died in each of the soybean lots. None died in the linseed oilmeal lot.

The Southwestern Test Farm, located in an extensive tobacco section, is partly given to tobacco investigations. From a fertility viewpoint two outstanding results of the work with tobacco are the response to applications of potash and the larger profit resulting from increased amounts of phosphoric acid.

TABLE 26.—Showing Effect of Fertilizers in Tobacco-Wheat-Clover Rotation, 21-year Averages

Fertilizers per acre per rotation			Yield per acre			Value of 3 crops	Cost fertilizer	3 crops over cost of fertilizer	Increase from fertilizer
Nitrate of soda	Acid phosphate	Muriate of potash	Tobacco	Wheat	Clover				
Lb.	*Lb.*	*Lb.*	*Lb.*	*Bu.*	*Lb.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*
0	0	0	510	10.9	2,150	$73.27	$0	$73.27	$0
0	480	0	724	21.2	3,190	113.64	4.80	108.84	35.57
0	480	180	1,084	24.4	3,640	150.62	9.30	141.32	68.05
240	320	180	1,111	24.8	3,284	150.71	16.10	134.61	61.34
240	480	180	1,149	24.7	3,540	155 52	17.70	137.82	64.55
240	720	180	1,269	27.3	2,830	171.19	20.10	151.09	77.82

Values—Acid phosphate $20, muriate of potash $50, nitrate of soda $70 a ton; wheat $1.50 a bushel; hay $15 a ton; and tobacco 8 cents a pound.

The Belmont County Farm is located in a hilly section where two outstanding needs are (1) pasture improvement and (2) the production of large yields of high feed-value crops on the limited areas of easily tillable land. Alfalfa and corn for silage and grain are the crops with high feeding value which fit into the dairy business scheme of this section.

The pasture improvement work has shown the necessity of both limestone and acid phosphate in rejuvenating the old run-out sod. Quicker results have been secured by disking and reseeding with white and alsike clover. Much of the pasture area, however, is too rough and broken for easy disking. Mowing twice a year has proved especially beneficial in cleaning up weedy pastures. Korean and Japan clovers show some promise, altho not as much as might be wished.

On the Clermont County Farm a remarkable difference is noted in the appearance, growth, and yield of apple trees when fertilized

with nitrogenous fertilizers. This is true in both the grass-mulch section and the tillage-cover-crop section. Altho sulphate of ammonia has been slightly superior to nitrate of soda in this test the opposite is true in Hamilton County where the nitrate plots lead in yield.

3-year Average Yield of Apples in Pounds Per Tree

	Nothing	Nitrate soda	Sulphate ammonia
Grass-mulch section	87	221	251
Tillage-cover-crop section	81	219	295

The Hamilton County Farm is located near a 1200 acre tract of land owned by a motor company where tractor farming is followed to the total exclusion of horses. The object of this company is to show that tractor farming is practical. However, it has the advantage of a nearby tractor factory where extra men may be secured on short notice on days favorable to work in the field. To study the problem from the standpoint of the individual farmer who must do his work himself, or with the help of a hired man, the Hamilton County Farm has eliminated horses from the dairy end of the farm. In 1925 the work connected with growing and harvesting 24 acres of corn, 15 acres of wheat, 20 acres of hay, and 16 acres of oats was performed entirely with tractors and accessories. No particular difficulties were encountered. However, the season was an extremely favorable one for the use of a tractor, and a different outcome may result in some future year with less favorable weather and soil conditions.

On the Madison County Farm winter steer-feeding tests are planned according to local conditions. During the winter of 1922-23, with hay plentiful and cheap, one lot received considerable clover. During the winter of 1923-24, following a good corn crop and when the grain was relatively more abundant than hay, the test included a comparison of heavy silage versus silage and shelled corn. The feeding period in each test was 140 days. The returns for 1923-24 were relatively large due to a $3 spread and cheap feed. Feeds and average gain per day per steer and return over feed cost per steer are summarized as follows:

TABLE 27.—Average Feed and Gain Per Day and Total Gain Per Steer

	Shelled corn	Clover hay	Corn silage	Cotton seed meal	Average daily gain	Returns per steer over feed costs
1922–23	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Dol.*
Lot 1	6.7	7.7	16 7	0.5	2.18	9.68
Lot 2	.....	1.7	45.4	2.0	2.12	6.91
1923–24						
Lot 1	.....	1.3	52	2	1.99	17.06
Lot 2	9.4	1.0	19	2	2.09	23.03

Mahoning County with a dense industrial population has had a rapid increase in vegetable and fruit growing to take care of the home market demand. The following 3-year average increases in yield of Early Jersey Wakefield cabbage in the vegetable fertility test are indicative of the benefit to be derived from limestone on vegetables in this section and also of the value of heavy fertilization with nitrogen, phosphorus, and potassium on what is not an especially favorable trucking soil.

TABLE 28.—Increase of Cabbage from Use of Limestone and Fertilizers

Treatment per acre	Increase from treatment
	Lb.
Limestone 1 ton every 2 years	2,093
Limestone 1 ton and acid phosphate 400 lb	2,360
Limestone 1 ton, acid phosphate 400 lb., nitrate of soda 160 lb	3,587
Limestone 1 ton, acid phosphate 400 lb., nitrate of soda 160 lb., and mur. potash 50 lb.	3,813
Limestone 1 ton, manure, 16 tons, and acid phosphate 400 lb	3,540

Miami County Experiment Farm comparisons of barley, oats, and spring wheat yields will help answer the question confronting many farmers of that section as to what spring-sown crop can best take the place of wheat following wide spread failure to get that crop sown in the fall of 1925. A spring sown crop is needed that can be grown without breaking up the rotation.

The results of these tests show that spring wheat has been less profitable han either barley or oats and that a choice of the latter two can well be made on the basis of which grain fits better into the farmers feeding scheme.

Average Yields of Barley, Oats, and Spring Wheat, 1915-1924

	Barley	Oats	Spring wheat (5 years)
Bushels per acre	34 bu.	56½ bu.	11½ bu.
Feeding nutrients per acre	1296 lb.	1273 lb.	

Another interesting thing at the Miami Farm that may be mentioned is the corn root-rot study supervised by the Department of Botany and Plant Pathology. This supplements a former test carried out on the Clermont County Farm. Altho as yet uncompleted this test just as with the one in Clermont County indicates that good fertility measures and simple precautions in seed selection will do much to offset the harm from any root-rot infection in the soil.

In Paulding County much grain farming is carried on, a common rotation being corn and oats without any legume crop for feed or fertility. A special clover test on the Paulding County Experiment Farm shows the beneficial effect on crop production of including a legume in the rotation, either as a plow-down crop in a short rotation or as a hay crop.

TABLE 29.—Crop Yields With and Without Clover, 6-year Average Yield Per Acre

	No clover	Mammoth clover	Medium red clover	Sweet clover
2-year rotation				
Corn	34.4 bu.	39.1 bu.	44.3 bu.	51.5 bu.
Oats	38.6 bu.	41.8 bu.	38.4 bu.	45.3 bu.
3-year rotation				
Corn		50.5 bu.	54.4 bu.	62.8 bu.
Oats		46.7 bu.	40.6 bu.	53.4 bu.
Clover		2.19 T.	1.24 T.	1.28 T.

In Trumbull County each year a crop is grown on drained land in comparison with undrained land. The results secured in eight years by growing two crops each of corn, oats, wheat, and a meadow mixture containing red clover, alsike clover, and alfalfa are as follow:

TABLE 30.—Average Yields on Drained and Undrained Land

	Corn	Oats	Wheat	Clover
Drained land	45 bu.	59 bu.	30 bu.	4,530 lb.
Undrained land	40 bu	46 bu.	17 bu.	5,300 lb.
Increase for drainage	12½ pct.	28 pct.	76 pct.	—14 pct.

In Washington County two farms are conducted, one a truck farm near Marietta where vegetable production is highly specialized, the other a general farm with fruit located near Fleming.

Of 12 treatments tested for eight years on the truck farm the following have been the most profitable for the crops indicated:

Sweet corn	400 pounds of acid phosphate and 160 pounds nitrate of soda
Cucumbers	Same as for sweet corn
Cabbage	1220 pounds of 4-10-4 fertilizer
Tomatoes	Same as for cabbage

In addition a basic treatment of 2 tons of limestone every other year proved highly profitable. Cover crops have been used each year to help maintain fertility.

On the farm at Fleming where orchard work has been done, the spraying work has shown that even the best spray materials cannot have most satisfactory results unless the application is thoroly made.

OHIO WEATHER FOR THE YEAR 1924

Briefly, the outstanding features of the weather in Ohio during the year 1924 were a persistent sub-normal temperature, great variation in the daily mean temperatures in January, November, and December, and the remarkable shortage of rain in October and early November. Only three times in the last 42 years was the State average (temperature) lower than in 1924—namely, 1885 (48.0), 1904 (48.6), and 1917 (47.9). The extremes for 1924 ranged from 20° below zero to 101° above zero; and the daily means ranged from 28° or more below normal to 24° or more above normal. A further indication of the cool character of the year may be found in the accumulated deficiency at the end of the year at the six regular Weather Bureau stations: Cincinnati, —499°; Cleveland, —680°; Columbus, —693°; Dayton, —752°; Sandusky, —774°; and Toledo, —720°. The deficiency was not only pronounced and persistent but it was general over the State.

Altho the State average percipitation shows a slight excess for the year, the fact is, for a very considerable part of the year and for the greater portion of the State, the precipitation was markedly deficient. The excess occurred almost entirely in the northern section, more particularly in the middle and eastern portions of that section. The precipitation was very deficient in the middle section, the average for the year being about 2½ inches below the normal. Then again we find the distribution thru the year was rather irregular, the greater portion occurring during the first six months, while in the last six months it was very deficient. There was no rain of consequence during the 40-day period beginning with October 1.

Characterizing by months: **January**—three cold, two warm waves, weather severe at times and generally unpleasant owing to frequency of sudden, sharp temperature changes; **February**—averaged about normal, very icy and disagreeable after the 5th, severe ice storm 18th-19th; **March**—persistently cold, little sunshine, high humidity, very disagreeable, 29th very warm with many thunderstorms; **April**—about normal, snowfall slightly more than average; **May**—one of the four coldest Mays of record, daily mean temperature continuously below normal after the 7th; killing frosts very general during the last decade; **June**—cool, humid, especially over the northern half of the State, with many thunderstorms and several tornadoes along the lake shore on 28th, with great damage at Lorain; **July**—continued cool, humid, with severe local storms, rainfall deficient; **August**—variable temperature, deficient rainfall, many destructive local storms in northern part of State; **September**—abnormally cool with excessive rainfall, many stations noting it as the coolest and wettest September of record, light frosts on the 6th, 10th, and 24th; **October**—driest October of record, much sunshine, one well-defined warm spell and one cool spell; **November**—much fine weather tho very dry first decade, variable temperature with two warm and two cold spells; **December**—great variety of weather, wide range in temperature, warm spell 5th-8th accompanied by thunderstorms, last decade decidedly cold, many stations recording the coldest Christmas Day of record.

The highest temperature for the year, 101°, was recorded at Chillicothe, Fremont, Middleport, and Valley Crossing and the lowest, —20°, at Bellefontaine; the highest annual mean, 54.1°, occurred at Portsmouth and the lowest, 45.9°, at Green Hill. The greatest amount of precipitation for the year, 45.95 inches, was recorded at Marietta and the smallest amount, 28.41 inches, at Put-in-Bay; the greatest monthly amount of precipitation was 12.36 inches at Lakeview in June, while five stations—Dublin, Fernbank, Franklin, Lakeview, and Prospect—reported none in October. The average number of days with 0.01 inch or more of precipitation was 124; the average number of clear days, 136; partly cloudy days, 101 and cloudy days, 129. The snowfall for the year averaged for the State 28 inches which is 5.7 inches below the normal; the greatest amount, 62 inches, was reported from Hiram; the greatest amount recorded in any one month was 16.9 inches at Warren in February. The prevailing direction of the wind was from the southwest.

WEATHER AT WOOSTER IN 1924

The temperature for January was below the average, with three cold periods during the month, the coldest was 10 degrees on the 6th. Heavy rainfall on the 10th and 11th putting creeks over their banks and caused almost flood conditions.

The temperature for February was very close to normal. The snowfall was 10.5 inches, some of which remained on the ground almost the entire month. Rain and sleet on the 19th and 20th covered the ground with ice, which remained to the end of the month.

March was noted for its steady cool weather, with no severe cold period, and only one warm period, that of the 28th and 29th, and but very little sunshine.

The temperature for April was about normal, with 3½ inches of snow on the 1st. The number of rainy days and lack of sunshine kept the season backward.

The weather for May was cloudy and cool; the total rainfall 4.13 inches, some rain falling on 23 different days. A heavy frost occurred on the 22d. The mean temperature for the month was 4 degrees below the average. The weather as a whole was unfavorabl for the seeding and growth of farm crops.

The month of June continued wet, rain falling on 20 days. The total rainfall was 6.4 inches as compared with 3.99 inches, the average of 36 years. The temperature was slightly below normal. A very severe electrical and wind storm occurred on the 29th.

For July the temperature was below, and the rainfall slightly above the 36-year average.

The rainfall for August was below normal, while the temperature was slightly above. The last week was extremely warm, the mercury reaching 95 degrees on the 31st.

September was cool with heavy rainfall, a total of 5.38 inches for the month.

The weather for October was fine, with an abundance of sunshine and many warm days. A minimum temperature of 21 degrees, with a killing frost, on the 23d marked the lowest temperature recorded here this early in October in 20 years. The rainfall for the month was only 0.30 inch. This light rainfall has been equalled but once in any month, at this Station, in the history of our records, this exception being in September, 1897, when the total fall for the month was only 0.29 inch.

The temperature for November was very close to normal; and the rainfall far deficient, only two Novembers in the last 36 years having had so little rain.

December was much colder than the average here, and extremely cold during the last week; a minimum of 11 degrees below zero was recorded on the 28th.

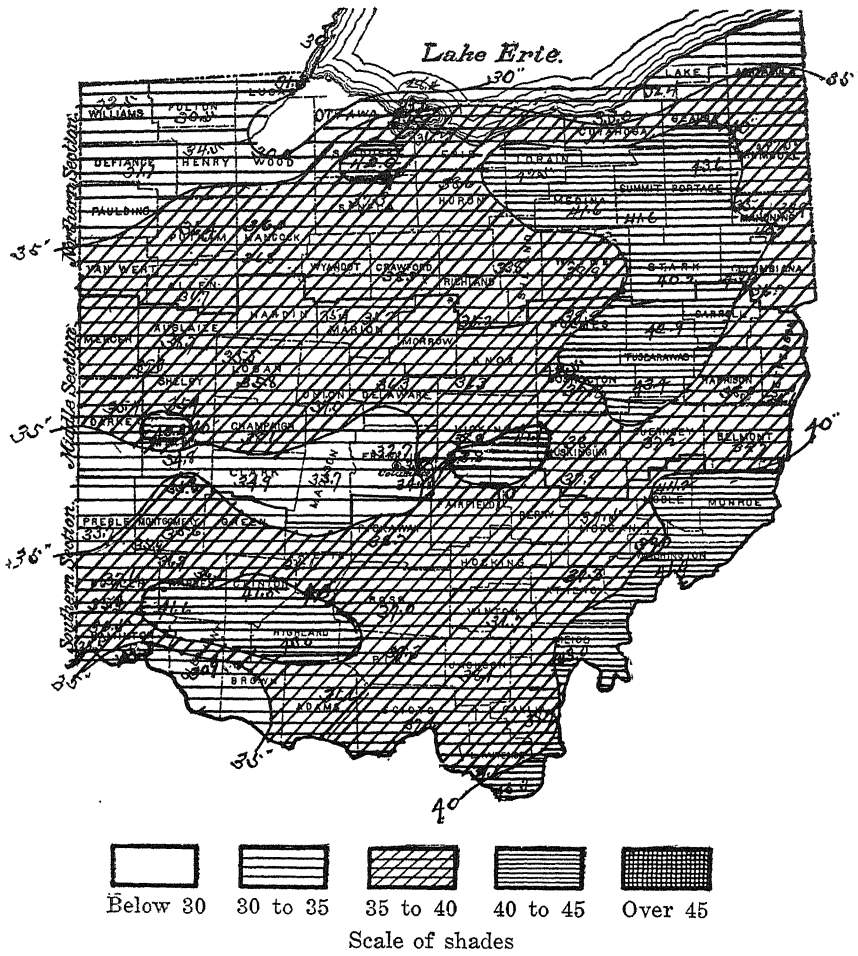


Fig. 15.—Precipitation in inches for the year, 1924

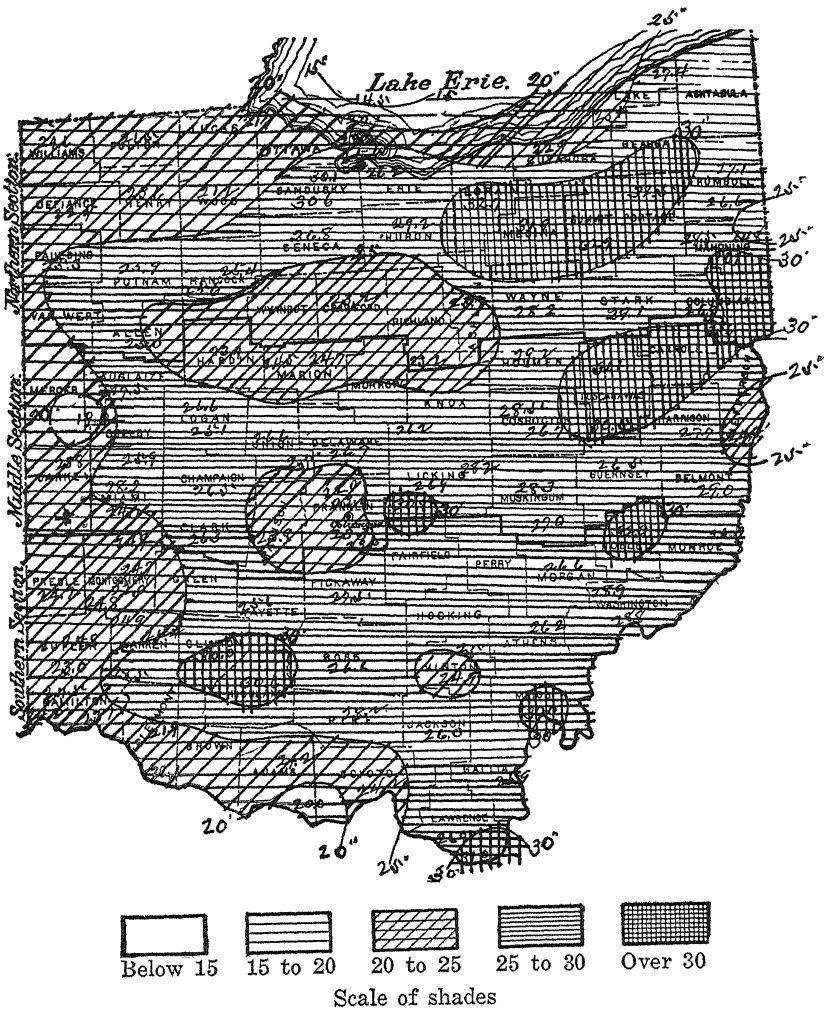


Fig. 16.—Total rainfall in inches during the growing season, March to September, inclusive, 1924

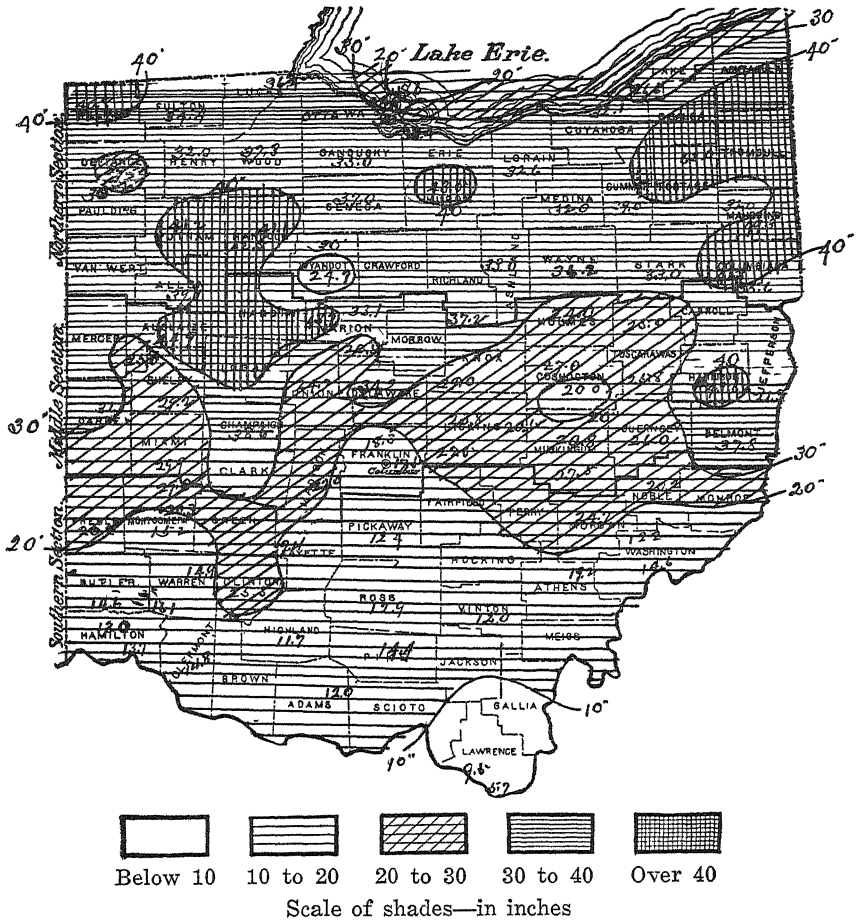


Fig. 17.—Total snowfall in inches for the year, 1924

TABLE 31.—Daily Rainfall and Melted Snow in Inches at Experiment Station, 1924

Date	January	February	March	April	May	June	July	August	September	October	November	December	Date
1	T			.35	.02	.30	.11		.01	T		.10	1
2			T	.03		.08			.47			T	2
3	.68	.02	.05		.27	.07						T	3
4	T		.09		T	.09	.08			T		T	4
5		.20	.17	T				.08				.47	5
6		.02		T		.51							6
7		.20	.05	.20			.50	.24	T	T	T		7
8		.10	T		T	1.23			T		.01	.22	8
9		T	T	.19	.12	.12		.42	.82				9
10	.30	.15	.10		T		.06		.30			T	10
11	1.40		.17		.54	.08		.11				T	11
12	T	.40	.02		.28	.68	.46	.07			T		12
13	.20	T			.01	.02	.05	.01	.81		.35		13
14				T	.93			.03			.04	.02	14
15		T			.54	.04							15
16	.47				.02	.07		.01			T		16
17	.02	.10		.03			.62	.27	.26			1.45	17
18	.02	T	.02	.84	.47	.60					.02	.55	18
19	.10	.10	T	.15	T				T	.12		.33	19
20	.10	.80						1.08	.64	.06		T	20
21		.05	.45	.11	T	.09	.51		T	.02	.32	T	21
22		T	.03	.26	T		1.61		.05	T	.05	.05	22
23		T	T	T		.74		.02			T	.05	23
24			T		.42						.12	.20	24
25	.20	.02		T	.02	.20		T					25
26	T		.55		.01		T						26
27			.10		.05	.42					.04	T	27
28	T		.02	.25	.08	.52	.03		.90		.02		28
29	T		.99		.33	.52			.70		T		29
30	.19		.01	.45	.02	.02			.42		.10		30
31			T				.29			.10			31
Total	3.68	2.16	2.82	2.86	4.13	6.40	4.32	2.34	5.38	.30	1.07	3.44	(Year) 38.90

TABLE 32.—A Climatological Summary for each Month, for the State and Wooster, 1924

Month	Temperature								Precipitation			Number of days			
	Monthly mean	Departure from normal	Highest	Date	Lowest	Date	Range	Greatest daily range	Average	Departure from normal	Average snowfall	With precipitation .01 inch or more	Clear	Part cloudy	Cloudy
State															
January	25.0	−3.3	64	1	−16	22	80	49	3.73	+0.63	5.7	10	11	6	14
February	28.7	+0.1	75	4	−8	24	83	45	2.02	−0.47	6.7	10	8	7	14
March	36.2	−3.4	83	29	10	2	73	41	3.53	+0.07	6.3	10	6	7	18
April	49.8	−0.3	90	14	17	2	73	55	2.71	−0.47	2.3	11	11	10	9
May	54.6	−6.2	94	7	27	22	67	52	4.10	+0.43	0	17	8	10	13
June	68.0	−1.3	99	20	35	7	64	44	6.38	+2.60	0	15	9	13	8
July	70.3	−3.3	98	24	41	2*	57	43	2.84	−1.10	0	9	17	10	4
August	72.0	+0.2	101	5*	38	19	63	48	2.12	−1.34	0	8	17	10	4
September	60.8	−4.8	96	1	31	24	65	46	4.80	+1.99	0	12	10	9	11
October	56.1	+2.2	90	19	20	23	70	53	0.26	−2.43	T	3	22	5	4
November	41.4	−0.1	79	7	6	29	73	48	1.44	−1.16	3.5	9	10	8	12
December	28.5	−2.7	74	18	−20	28	94	48	3.41	+0.62	3.5	10	7	6	18
The year	49.3	−1.9	101	Aug. 5*	−20	Dec. 28	121	55	37.34	−0.63	28.0	124	136	101	129
Wooster															
January	24.7	−2.5	51	1*	−10	6	57	37	3.68	+0.44	7.50	11	6	5	20
February	27.0	+0.3	61	4	1	26	60	37	2.16	−0.35	10.50	12	5	9	15
March	35.1	−2.4	73	29	15	2	58	31	2.82	−0.76	8.75	15	4	7	20
April	48.3	−0.1	75	24	21	2	54	42	2.86	−0.22	3.75	11	7	12	11
May	54.2	−4.0	85	6	32	22	53	35	4.13	+0.15	.....	17	8	5	18
June	66.7	−0.9	94	20	42	2	52	36	6.40	+2.35	.....	20	10	14	6
July	68.7	−2.7	92	29	42	3	50	33	4.32	+0.22	.....	11	21	10	0
August	70.5	+0.9	95	5*	44	18	51	40	2.34	−1.25	.....	11	22	7	2
September	60.3	−3.5	88	1	35	24	53	34	5.38	+2.14	.....	11	7	12	11
October	53.7	+1.8	80	5	21	23	59	42	0.30	−2.24	.....	4	22	4	5
November	40.3	+0.3	75	7	14	18	61	38	1.07	−1.58	1.50	10	7	5	18
December	26.9	−3.4	59	17	−11	28	70	30	3.44	+0.65	4.25	10	3	3	25
The year	48.0	−1.4	95	Aug. 5*	−11	Dec. 28	106	42	38.90	−0.38	36.25	143	122	93	151

*On other dates also.

TABLE 33.—Temperature and Precipitation for the State and for Wooster

Year	State					Wooster				
	Temperature			Precipitation		Temperature			Precipitation	
	Mean	Max.	Min.	Annual	Growing season*	Mean	Max.	Min.	Annual	Growing season*
1888	49.5	102	—15	39.64	24.55	47.4	92	—5	38.05	22.76
1889	51.1	100	—14	33.41	20.32	48.6	92	—6	39.87	24.30
1890	52.2	103	—4	50.33	30.97	49.7	95	1	52.69	33.22
1891	51.8	101	—5	38.61	21.73	49.0	99	0	38.48	20.76
1892	50.2	103	—27	37.16	27.26	48.0	98	—20	41.53	32.02
1893	50.0	102	—24	39.63	22.69	48.7	95	—9	40.58	21.10
1894	52.4	105	—27	29.75	17.66	50.6	98	—7	30.78	17.13
1895	50.0	106	—24	28.46	14.59	47.8	98	—6	30.91	17.66
1896	51.8	102	—18	39.58	30.22	49.3	93	—6	39.10	29.57
1897	51.5	113	—27	38.59	23.07	49.4	96	—18	36.76	21.55
1898	52.2	105	—20	43.78	26.61	50.4	96	—9	47.85	30.77
1899	51.5	107	—39	34.32	22.18	49.5	95	—21	32.93	21.42
1900	52.2	103	—20	32.82	19.71	50.7	95	—10	36.61	23.70
1901	50.2	109	—20	32.36	23.37	48.7	95	—11	35.89	27.23
1902	50.7	100	—17	37.58	26.45	49.5	97	—9	32.95	23.28
1903	50.5	104	—20	36.85	22.75	49.1	94	—9	40.44	26.38
1904	48.6	99	—30	36.19	24.69	47.1	92	—21	41.28	28.16
1905	50.0	100	—22	39.08	27.20	48.8	92	—12	42.93	33.30
1906	51.6	101	—23	36.88	24.28	50.7	92	—14	42.82	30.10
1907	49.6	98	—23	42.85	28.09	48.4	90	—14	40.00	24.91
1908	52.1	104	—22	34.10	23.62	51.0	95	—3	33.94	22.73
1909	50.9	97	—20	42.66	26.58	50.0	90	—11	44.22	28.43
1910	50.4	100	—25	36.03	19.01	49.2	94	—12	35.45	15.86
1911	52.6	107	—19	42.63	22.95	50.8	101	—11	47.15	28.28
1912	49.6	101	—37	37.82	27.82	47.8	93	—24	46.60	36.40
1913	52 3	105	—15	44.75	27.24	50.6	96	—2	51.18	32.03
1914	50.9	106	—24	35.41	21.36	49.2	95	—18	37.38	25.11
1915	50.8	99	—22	40.83	26.56	48.9	91	—13	42.06	28.88
1916	51.0	104	—18	37.24	23.22	48.9	99	—7	34.93	21.18
1917	47.9	103	—31	36.51	24.64	46.3	96	—18	31.82	20.56
1918	51.5	110	—28	36.54	22.89	50.5	105	—19	33.75	20.74
1919	52.3	106	—12	40.33	25.10	51.2	95	—4	43.08	30.52
1920	50.3	98	—11	37.49	26.90	49.1	93	—5	39.70	30.64
1921	54.6	103	2	42.97	26.83	53.3	96	9	41.90	27.85
1922	52.8	101	—20	37.04	27.11	51.3	96	—11	34.42	23.94
1923	51.4	100	—7	39.02	25.58	50.2	97	—1	36.30	20.73
1924	49.3	101	—20	37.34	26.48	48.0	95	—11	38.90	28.25
Average	51.0	.....	.....	38.01	24.39	49.4	.....	.....	39.33	25.98

*March to September, inclusive.

TABLE 34.—Monthly Mean Temperature at Experiment Farms and for the State

Farm	January	February	March	April	May	June	July	August	September	October	November	December	Year
Wooster 1924	24.7	27.0	35.1	48.3	54.2	66.7	68.7	70.5	60.3	53.7	40.3	26.9	48.0
Av. 37 years	27.2	26.7	37.5	48.4	58.2	67.6	71.4	69.6	63.8	51.9	40.0	30.3	49.4
Germantown 1924	26.2	30.9	37.2	52.8	55.4	69.8	70.8	72.6	61.9	58.3	43.0	29.6	50.7
Av. 10 years	28.9	32.3	41.7	51.9	60.7	70.5	74.2	72.4	66.0	55.9	43.4	32.8	52.6
Batavia 1924	27.4	32.0	38.4	53.9	57.4	71.4	71.8	73.8	61.8	59.2	44.0	31.2	51.9
Av. 9 years	31.1	33.0	44.3	52.9	62.2	71.5	75.0	75.0	66.8	57.1	44.1	34.3	54.9
Canfield 1924	22.8	23.2	33.4	46.4	51.6	63.9	66.8	68.2	58.4	51.6	39.6	26.0	46.0
Av. 9 years	24.6	27.1	38.6	47.3	56.9	66.5	70.2	68.7	62 2	51.6	39.5	29.6	48.4
Marietta 1924	29.2	32.0	39.0	52.3	56.4	70.1	72.0	73.8	60.0	55.7	41.8	33.5	51.3
Av. 9 years	30.9	33.2	43.7	52.3	61.7	70.7	74.1	73.0	65.3	55.2	42.6	34.4	53.2
Mt. Healthy 1924	26.4	31.0	37.9	53.9	56.2	71.4	71.8	74.0	62.6	59.4	43.6	30.7	51.6
Av. 9 years	29.9	32.3	44.2	52.2	61.8	71.3	74.8	73.8	66.9	56.7	44.3	33.8	53.5
Paulding 1924	21.6	25.8	34.4	48.4	53.5	65.2	69.2	70 6	60.4	55.8	39.2	25.2	47.4
Av. 9 years	24.6	26.7	38 7	48.2	58.5	68.9	73.0	71.6	64.8	53.1	40.2	29.3	49.6
State 1924	25.0	28.7	36.2	49.8	54.6	68.0	70.3	72.0	60.8	56.1	41.4	28.5	49.3
Av. 37 years	28.5	28.4	39.1	49.9	60.4	69.6	73.3	71.4	65.3	53.5	41.4	31.6	51.0

TABLE 35.—Monthly Rainfall at Experiment Farms and for the State

Farm	January	February	March	April	May	June	July	August	September	October	November	December	Year
Wooster 1924	3.68	2.16	2.82	2.86	4.13	6.40	4.32	2.34	5.38	.30	1.07	3.44	38.90
Av. 37 yr	3.24	2.51	3.58	3.08	3.98	4.05	4.10	3.59	3.24	2.54	2.64	2.79	39.33
Carpenter 1924	......	......	......	......	......	......	......	......	......	......	......	......	......
Av. 19 yr	3.83	2.59	3.64	3.27	3.76	4.06	3.52	3.24	2.25	2.68	2.17	3.13	38.12
Germantown 1924	4.12	1.50	4.27	2.17	3.72	5.92	4.18	2.09	2.45	0.23	1.48	3.78	35.91
Av. 20 yr	3.70	2.41	4.11	3.78	3.86	3.15	3.45	4.38	2.90	2.84	2.52	3.09	39.43
Strongsville 1924	1.84	.24	1.07	2.67	4.45	8.20	3.24	2.05	6.63	.86	.69	3.57	35.51
Av. 25 yr	2.76	1.94	3.16	3.35	3.65	3.25	3.82	3.77	3.59	2.71	2.61	2.85	39.44
Batavia 1924	3.33	1.74	2.32	2.28	3.21	6.35	2.28	2.18	3.27	0.34	1.31	2.31	30.92
Av. 9 yr	3.56	1.59	3.59	3.51	3.82	3.07	2.99	4.42	2.64	2.83	2.37	3.50	38.88
Canfield 1924	4.39	2.28	2.39	3.26	6.62	6.82	2.01	2.30	7.76	0.31	1.03	2.54	41.71
Av. 9 yr	2 31	1.38	2.55	3.37	3.95	4.06	3.43	2.68	3.31	2.60	2.43	2.40	34.64
Marietta 1924	3.97	2.66	3.15	2.69	4.52	3.01	3.82	1.61	6.80	0.10	1.63	2.52	36.48
Av. 9 yr	3.35	2.04	3.69	3.68	4.15	4.29	4.24	3.78	3.03	2.85	2.88	3.43	40.59
Mt. Healthy 1924	4.46	1.83	5.05	2.39	3.45	4.88	1.88	3.70	3.11	0.22	1.36	4.15	36.48
Av. 9 yr	3.77	1.93	4.70	3.84	3.75	3.85	3.24	3.87	3.27	3.02	2.64	3.81	40.48
Paulding 1924	2.58	1.09	4.08	2.66	3.87	6.40	1.96	2.28	4.05	0.78	1.22	5.23	36.20
Av. 9 yr	2.11	0.97	3.77	3.14	4.26	3.68	2.90	2.21	2.66	3.02	2.27	3.04	34.71
State 1924	3.73	2.02	3.53	2.71	4.10	6.38	2.84	2.12	4.80	0.26	1.44	3.41	37.34
Av. 37 yr	3.09	2.48	3.59	3.15	3.74	3.84	3.84	3.36	2.86	2.55	2.67	2.81	38.02

TABLE 36.—Date of First and Last Killing Frost, Length of Growing Season, and Number of Days the Mercury Registered Zero or Below at the Experiment Station at Wooster Each Year

Year	Date of killing frost		Length of growing season, days	Number of days mercury registered zero or below				
	Last in spring	First in autumn		Jan.	Feb.	March	Dec.	Total
1894	April 13	October 7	177	.....	2	.....	2	4
1895	May 22	September 28	129	5	7	.....	2	14
1896	April 24	September 24	153	1	3	.....	.....	4
1897	May 26	September 21	118	4	.....	.....	.....	4
1898	May 9	October 16	160	1	3	.....	.....	4
1899	May 22	September 30	131	3	8	.....	2	13
1900	May 10	October 18	161	2	5	1	.....	8
1901	May 16	October 2	139	2	1	1	4	8
1902	April 28	September 16	141	.....	5	.....	1	6
1903	May 4	October 23	172	3	3	.....	6	12
1904	April 20	September 22	155	7	8	.....	1	16
1905	May 4	October 13	142	3	10	.....	.....	13
1906	May 10	October 11	154	.....	6	1	.....	7
1907	May 12	October 14	155	5	3	.....	.....	8
1908	April 17	September 30	166	.....	1	.....	.....	1
1909	May 12	October 19	160	1	1	.....	1	3
1910	May 15	October 29	167	3	6	.....	1	10
1911	May 5	October 24	172	1	.....	.....	.....	1
1912	June 8	September 30	114	12	7	.....	.....	19
1813	June 10	September 23	105	.....	1	.....	.....	1
1914	May 2	October 27	178	1	6	.....	5	12
1915	May 27	October 10	136	4	1	.....	.....	5
1916	April 28	September 19	144	2	1	1	5	8
1917	May 11	October 1	143	2	8	.....	9	19
1918	May 2	October 1	152	8	4	.....	.....	12
1919	April 27	October 13	169	.....	.....	.....	2	2
1920	May 16	October 7	144	4	1	.....	.....	5
1921	May 17	October 13	149	.....	.....	.....	.....	0
1922	May 1	September 26	148	4	1	.....	1	6
1923	May 10	September 14	127	.....	1	.....	.....	1
1924	April 23	October 23	183	6	.....	.....	4	10
Av.	May 10	October 7	149	84	103	4	46	237

REPORT OF THE BURSAR

1924-1925

CONSOLIDATED STATEMENT

ASSETS AND LIABILITIES

ASSETS

Current Assets	$120,591.25	
Land	241,457.73	
Land Improvements	33,528.68	
Buildings	415,230.66	
Departmental Equipment	243,549.07	
Total Assets		$1,054,357.39

LIABILITIES

Capital Account	$943,063.64	
Special State Appropriations	111,293.75	
Total Liabilities		$1,054,357.39

INCOME AND EXPENDITURES

INCOME

Cash Balance July 1, 1924		$ 18,164.32	
Appropriations by Legislature	$534,290.13		
" by U. S. Government	32,375.05		
Sale of Produce, etc.	50,041.19		
Total Income		616,706.37	
Total			$ 634,870.69

EXPENDITURES

Salaries	$197,345.09	
Employees and Extra Labor	111,699.89	
Stationery and Office Supplies	2,273.33	
Incidentals	4,638.71	
Laboratory Supplies	4,575.25	
Materials and General Supplies	44,041.88	
Repairs to Equipment	5,561.90	
Telephone and Telegraph	883.52	
Freight and Cartage	6,160.50	
Traveling Expense	18,673.57	
Feed	29,248.07	
Fertilizers	733.25	
Apparatus	2,017.76	
Furniture and Fixtures	464.63	
Machinery, Tools, etc.	8,974.01	
Library	391.62	
Livestock	6,769.91	
Land	60,719.70	
Land Improvements	3,517.31	
Building Improvements	3,089.16	
New Buildings	103,794.13	
Total Expenditures		$ 615,573.19
Cash Balance June 30, 1925		$ 19,297.50